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SERVICE MANUAL

LOMBARDINI

SERVICE

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1.1 PURPOSE OF THE MANUAL

- This manual was written by the manufacturer to provide technical and operating information to authorised **LOMBARDINI** after-sales service centres to carry out assembly, disassembly, overhauling, replacement and tuning operations.

- This information is provided by the manufacturer in its own language (Italian) and may be translated into other languages to satisfy legislative and/or commercial requirements.

- As well as employing good operating techniques and observing the right timing for operations, operators must read the information very carefully and comply with it scrupulously.

- Time spent reading this information will help to prevent health and safety risks and financial damage.

- Written information is accompanied by illustrations in order to facilitate your understanding of every step in the operating phases.

- Important remarks and features of the text are highlighted using symbols, which are explained below.

Danger – Attention

This indicates situations of grave danger, which, if ignored, may seriously threaten the health, and safety of individuals.

Caution – Warning

This indicates that it is necessary to take proper precautions to prevent any risk to the health and safety of individuals and avoid financial damage.

Important

This indicates particularly important technical information that should not be ignored.

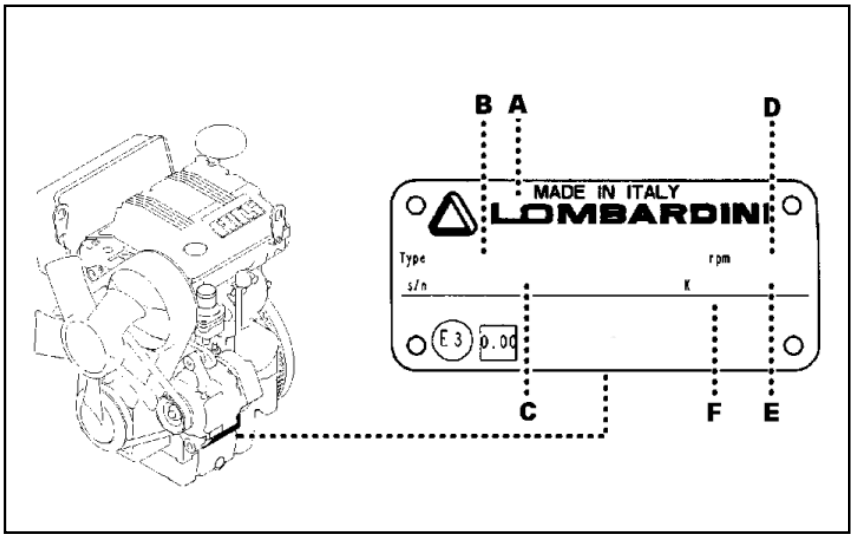
1.2 USING THIS MANUAL

- This manual is divided into several chapters.
- The first chapter gives general information and details about safety (purpose of the manual, safety, etc.).
- The second, third and fourth chapters provide general technical information (technical specifications, diagrams, tightening torques, malfunctions, etc.).
- The fifth, sixth, seventh and eighth chapters describe the most important operating procedures (removal, overhaul and tuning, installation, replacements, etc.).
- This final section, which is reserved specifically for **LOMBARDINI** after-sales service centres, has been prepared with technical and practical considerations in mind.
- However, the actual sequence of operations that **LOMBARDINI** service centres must use may in some cases be different from the ones described in this manual. For this reason, the reader should refer to the index to find his/her topic of interest quickly.

1.3 MANUFACTURER AND ENGINE IDENTIFICATION

The identification plate shown in the figure can be found directly on the engine. It contains the model, engine identity and all information needed to operate safely.

A) Manufacturer's identity
B) Engine type
C) Engine serial number
D) Maximum speed
E) Customer code
E) Approval data



1.4 GLOSSARY AND TERMINOLOGY

For clarity, here are the definitions of a number of terms used recurrently in the manual.

- **Piston number one:** first piston “viewed from the flywheel side of the engine”.

- **Rotation direction:** clockwise or anticlockwise “viewed from the timing belt side of the engine”..

1.5 WARRANTY CLAUSES

LOMBARDINI issues a warranty certificate for each engine giving details of all relevant general terms.

1.6 GENERAL SAFETY REGULATIONS

- In designing and building its product, the manufacturer has paid particular attention to those aspects posing a risk to the health and safety of persons handling the engine. In addition to legislative requirements, all “rules for good technical construction” have been applied.

- The purpose of this information is to invite operators to pay particular attention in order to prevent any form of risk. Caution is always the best policy. Safety is also the responsibility of all operators who handle the engine.

- All persons carrying out work on the engine at any point in its life must possess precise technical qualifications and skills, as well as experience recognised and gained in the specific sector. Non-compliance with these requirements may cause damage to the health and safety of individuals.

- Do not tamper with, sidestep, eliminate or bypass the installed safety devices. Non-compliance with this requirement may be hazardous to the health and safety of individuals.

1.7 GENERAL SAFETY DURING OPERATING PHASES

- The procedures contained in this manual have been tested and selected by the manufacturer’s technical experts, and hence are to be recognised as authorised operating methods.

- A number of procedures must be carried out with the aid of equipment and tools that simplify and improve the timing of operations.

- Some of these tools are normal workshop equipment, while others are specific instruments that have been constructed by the engine manufacturer.

- All tools must be in good working condition so that engine components are not damaged and that operations are carried out properly and safely.

- It is important to wear the personal safety devices prescribed by work safety laws and also by the standards of this manual.

- Holes must be lined up methodically and with the aid of suitable equipment. Do not use your fingers to carry out this operation to avoid the risk of amputation.

- Some phases may require the assistance of more than one operator. If so, it is important to inform and exercise them regarding the type of activity they will be performing in order to prevent risks to the health and safety of all persons involved.

- Do not use flammable liquids (petrol, diesel, etc.) to degrease or wash components. Use special products.

- Keep flames away from the engine to avoid the risk of fire.

- Replace worn or damaged parts exclusively with original LOMBARDINI spare parts. This will contribute to ensuring better performance and longer product life.

- Use the oils and greases recommended by the manufacturer. Do not mix different brands or oils with different characteristics.

- Use a torque wrench to tighten the main fixing points of engine components. Stick to the tightening torques indicated by the manufacturer.

- Discontinue use of the engine if any irregularities arise, particularly in the case of unusual vibrations.

- The engine has been designed and built to satisfy all the operating conditions described by the manufacturer.

- Do not tamper with any devices to alter the level of performance guaranteed by the manufacturer.

1.8 SAFETY AND ENVIRONMENTAL IMPACT

Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment.
Procedures for identifying the extent of the impact on the environment must consider the following factors:

- Liquid waste
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- Regulations and directives regarding environmental impact

In order to minimise the impact on the environment, the manufacturer now provides a number of indications to be followed by all persons handling the engine, for any reason, during its expected lifetime.

- All packaging components must be disposed of in accordance with the laws of the country in which disposal is taking place.
- Keep exhaust pipes in efficient working order to limit the noise level of the engine and reduce environmental pollution.
- When discontinuing use of the engine, select all components according to their chemical characteristics and dispose of separately.

1.9 PRECAUTIONS WHEN THE ENGINE IS INSTALLED ON THE MACHINE

- All operations, except where expressly stated otherwise, must be carried out when the engine is not running and has cooled sufficiently to avoid the risk of burns.

- Do not keep the engine running in areas that are closed and inadequately ventilated. Take all necessary precautions to prevent a build up of exhaust fumes.

1.10 PRECAUTIONS WHEN THE ENGINE IS ON THE ROTATING STAND

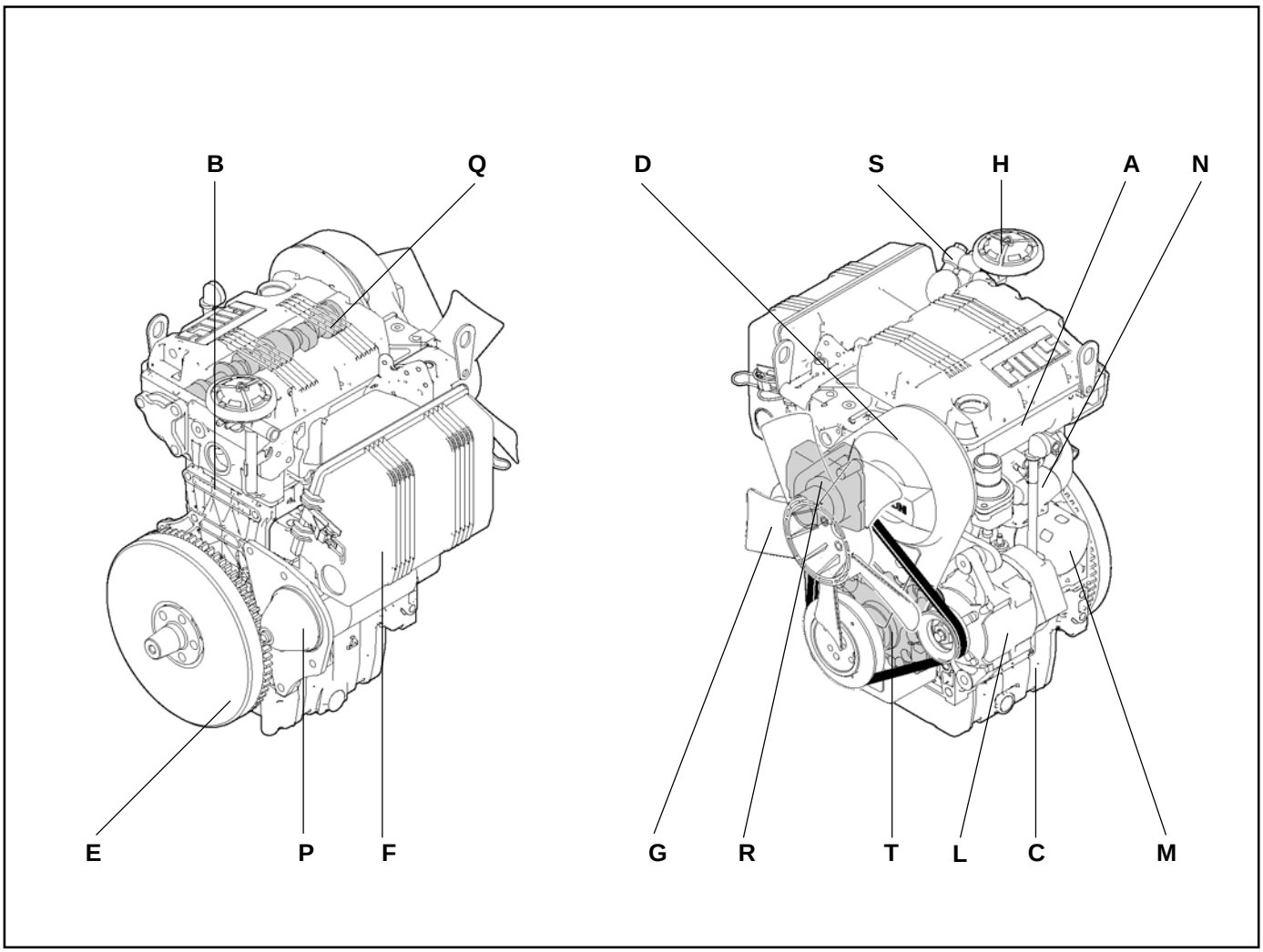
- Before removing the engine from the machine on which it is installed, disconnect the electric current, the fuel supply, coolant and all connections including mechanical ones.
- To lift the engine, attach the lifting device at the points (eyebolts) specified by the manufacturer.
- Close all engine openings carefully (exhaust, intake, etc.) wash the outside and dry with a jet of compressed air.
- Anchor the engine to the rotating stand to facilitate all operations.

Note: the engine may also be placed on the workbench, depending on the type of work to be carried out.

Notes :

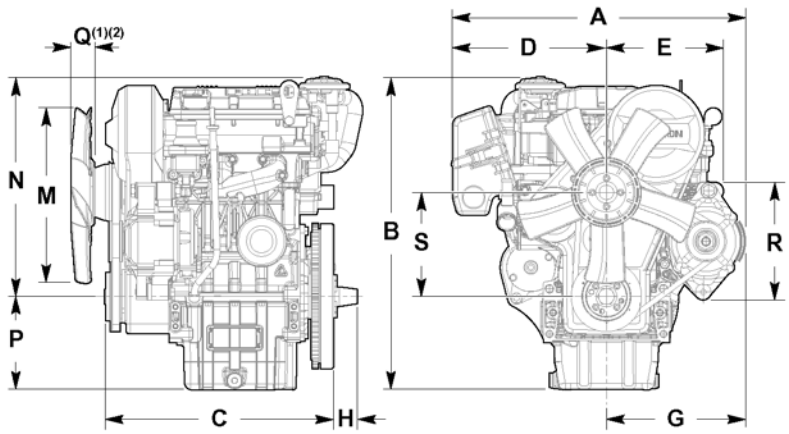
2.1 GENERAL DESCRIPTION OF THE ENGINE

Main components



A) Cylinder head
B) Engine block
C) Crankcase
D) Timing belt assembly
E) Flywheel and crankshaft assembly
F) Air intake assembly
G) Cooling fan
H) Negative-pressure vent valve
L) Alternator
M) Oil filter
N) Exhaust manifold
P) Starter motor
Q) Camshaft
R) Coolant pump
S) Fuel supply pump
T) Oil pump

2.2 TECHNICAL SPECIFICATIONS



DIMENSIONS (mm)												
A	451	C	353	E	181	H	36	N	340	Q	51(1)	R	182
B	491	D	238	G	213	M	280	P	151		52(2)	S	160

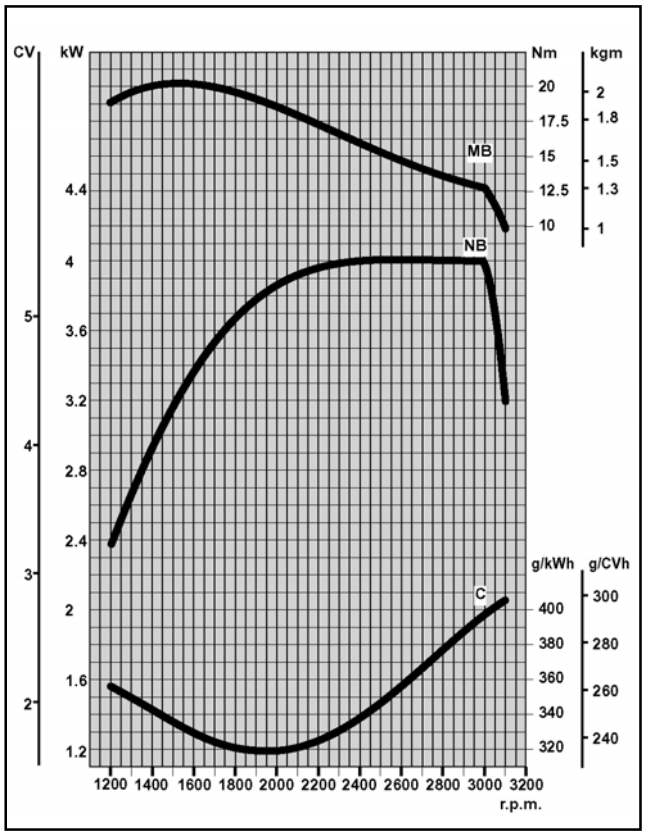
(1) with suction fan
(2) with blower fan

GENERAL DETAILS		
Operating cycle	4-stroke diesel	
Number of cylinders	n°	2
Bore x stroke	mm	72x62
Displacements	cm^3	505
Compression rate	22,8:1	
Intake	Air filter (dry)	
Filter capacity	µm	13÷14
Filtering surface	cm^2	4470
Cooling	Water	
Driving shaft rotation	Clockwise (from distribution side)	
Combustion sequence	1:2	
Timing system	Synchronous toothed belt	
Dry weight of engine	Kg	60
Maximum tilt while operating	no more than 1 minute	35°
Maximum tilt while operating	no more than 30 minutes	25°
Maximum tilt while operating	normal operating conditions	0°
Volume of air flow (at 3600 RPM)	Nl/min	910
Volume of cooling air (at 3600 RPM)	m^3/min	36
POWER AND TORQUE		
Maximum operating speed	RPM	3600
Max. power (N 80/1269/EEC - ISO 1585 - DIN 7020)	kW (CV)	9.8 (13.4)
Max. power (NB ISO 3046 - 1 IFN - DIN 6270)	kW (CV)	9.1 (12.4)
Max. power (NA ISO 3046 - 1 ICXN - DIN 6270)	kW (CV)	8.2 (11.2)
Maximum torque (at 2400 RPM)	Nm	28.7
Axial load allowed on driving shaft	Kg	300

CONSUMPTION AT MAXIMUM POWER		
Specific fuel onsumption	g/kWh	326
Specific oil consumption	Kg/h	0,007
SUPPLY CIRCUIT		
Supply type	Indirect injection	
Fuel type	Car diesel	
Fuel supply	Electric or membrane pump	
Fuel filter	Screw-on or in-line “fispino”	
Filter paper	m	PF905
Filtering surface	cm^2	2400
Filter capacity	µ	2÷3
Maximum operating pressure	bar	4
LUBRIFICATION CIRCUIT		
Type of lubrication	Completely forced	
Circuit supply	Trochoid pump	
Maximum oil quantity	including filter (l)	1,4
Maximum oil quantity	excluding filter (l)	1,3
Oil pressure at minimum speed (with oil temperature of 120°C)	no lower than 1 bar	
Oil filter cartridge		
Maximum operating pressure	bar	7
Maximum combustion pressure	bar	20
Filter capacity	µ	15
By-pass valve setting	bar	1,5÷1,7
Filtering surface	cm^2	730
COOLING CIRCUIT		
Coolant	50% water - 50% antifreeze fluid	
Thermostatic valve		
Opening temperature	°C	83°÷87°
Max stroke (at 94°C)	mm	7
Liquid return	l/h	30÷80
ELECTRICAL EQUIPMENT		
Nominal voltage	V	12
Alternator (nominal voltage)	V	14
Internal/external alternator (nominal current) (see “Alternator load curve diagrams”)	A	40
Starter motor power	Kw	1,1
Preheating glow plugs		
Nominal voltage	V	12,5
Absorption (after 5 seconds)	A	12÷14
Surface temperature of the sheath	°C	850°
Control unit temperature sensor		
Working field	°C	-30°÷80°
Voltage	V	6+24
Max. temperature	°C	150°
Oil pressure switch		
Operating pressure	bar	0,15÷0,45
Coolant temperature monitoring sensor		
Electric circuit	Unipolar system	
Supply voltage	V	6÷24
Absorbed power	W	3
Closed circuit temperature	°C	107°÷113°

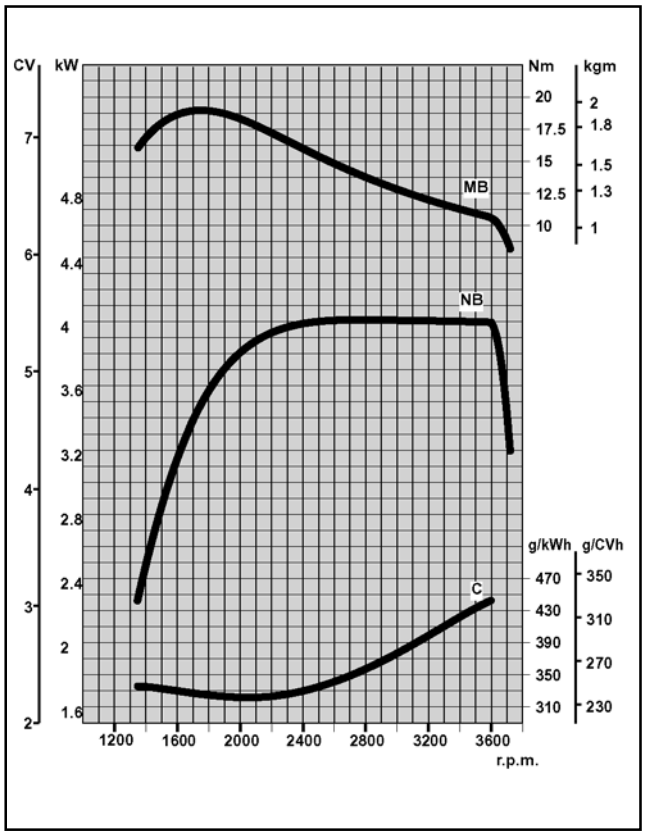
2.3 CHARACTERISTIC CURVE DIAGRAMS

Power curve diagram 80/1269/CEE - 95/1/CE (3000 tr/min)



Legend
NB = Power curve
MB = Torque curve
C= Specific consumption curve

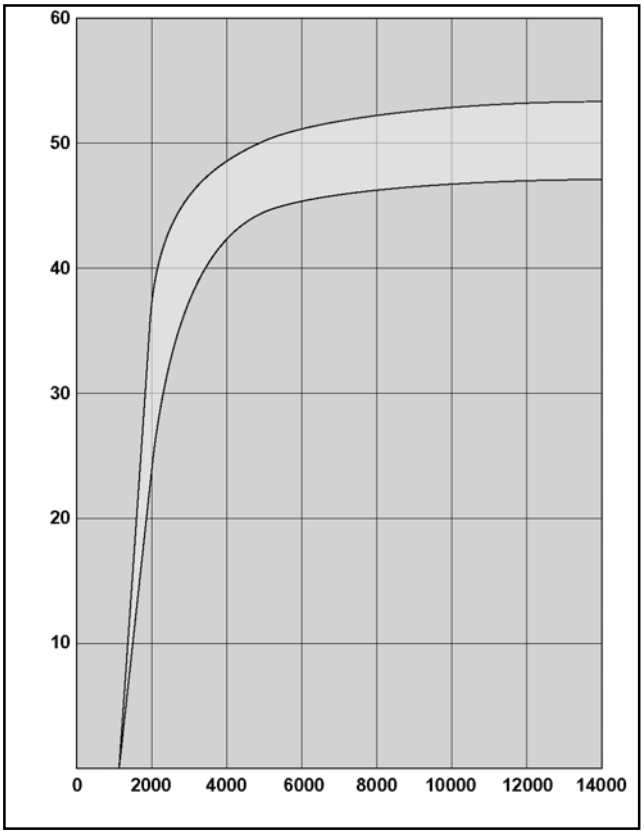
Power curve diagram 80/1269/CEE - 95/1/CE (3600 tr/min)



2.4 ALTERNATOR LOAD CURVE DIAGRAMS

Internal load curve diagram

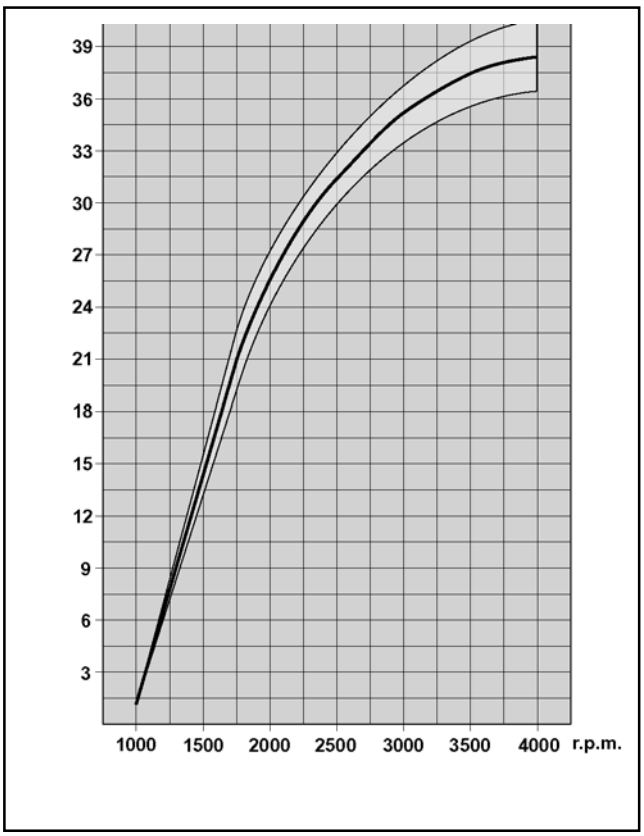
Reading taken after heat stabilisation at 25°C and constant voltage 13,5V.



* To determine engine r.p.m.s, check the gear ratio adapted to pulleys.

External load curve diagram

Reading taken after heat stabilisation at 20°C and constant voltage 12,5V.

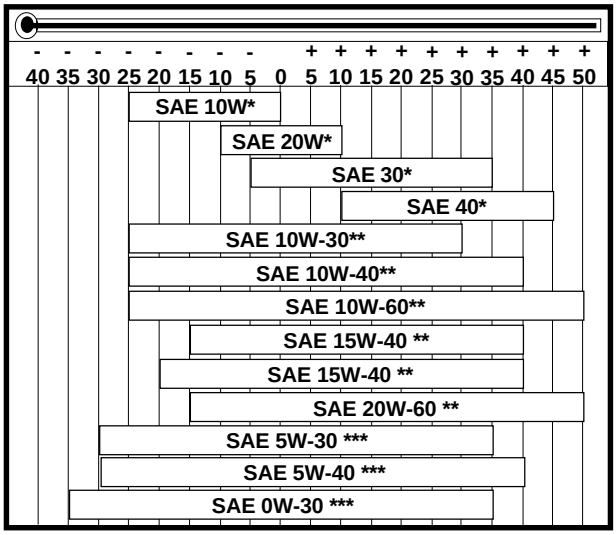


** The alternator turns at the same rate as the engines.

2.5 LUBRIFICANTS

2.5.1 SAE Classification

In the SAE classification, oils differ on the basis of their viscosity, and no other qualitative characteristic is taken into account.
The first number refers to the viscosity when the engine is cold (symbol W = winter), while the second considers viscosity with the engine at régime.
The criteria for choosing must consider, during winter, the lowest outside temperature to which the engine will be subject and the highest functioning temperature during summer.
Single-degree oils are normally used when the running temperature varies scarcely.
Multi-degree oil is less sensitive to temperature changes.



** Mineral base*
*** Semi-synthetic base*
**** Sythetic base*

Key to abbreviations
A.P.I. : (American Petroleum Institute)
MIL : USA military specifications for engine oils issued for logistic reasons
ACEA : European Automobile Manufacturers Association

2.5.2 API/MIL Sequences

	DIESEL										BENZINA - ESSENCE - PETROL BENZIN - GASOLINA									
API	CH-4	CG-4	CF-4	CF-2	CF	CE	CD	CC	CB	CA	SA	SB	SC	SD	SE	SF	SG	SH	SJ	SL
MIL						L - 2104 D / E					L - 46152 B / C / D / E									
	CORRENTI - CURRENT										OBSOLETI - OBSOLETE									

2.5.3 ACEA Standards - ACEA Sequences

PETROL

A1 = Low-viscosity, for friction reduction
A2 = Standard
A3 = High performance

LIGHT DIESELS

B1 = Low-viscosity, for friction reduction
B2 = Standard
B3 = High performance (indirect injection)
B4 = High quality (direct injection)

HEAVY DIESELS

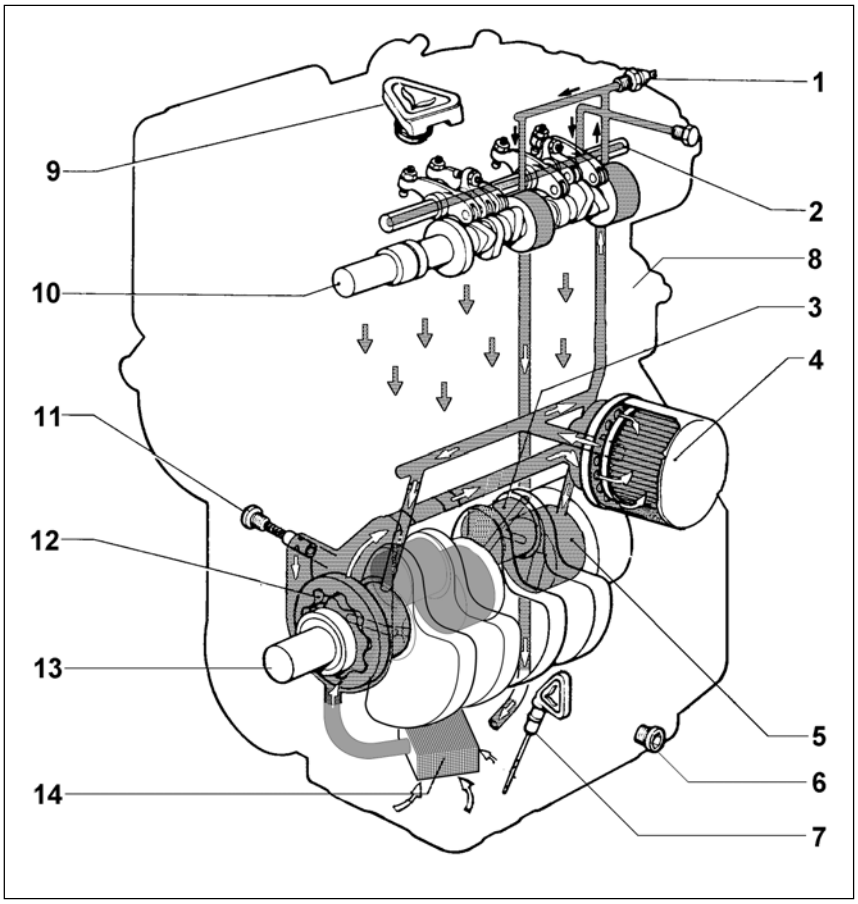
E1 = *OBSOLETE*
E2 = Standard
E3 = Heavy conditions (Euro1 - Euro2 engines)
E4 = Heavy conditions (Euro1 - Euro2 - Euro3)
E5 = High performance in heavy conditions (Euro1 - Euro2 - Euro3 engines)

2.5.4 Recommended oil

Description	*Oil type*	*Oil characteristics*
Engine oil	Agip SINT 2000 5W40	API SJ/CF ACEA A3-96 B3-96 MIL-L-4615 D/E

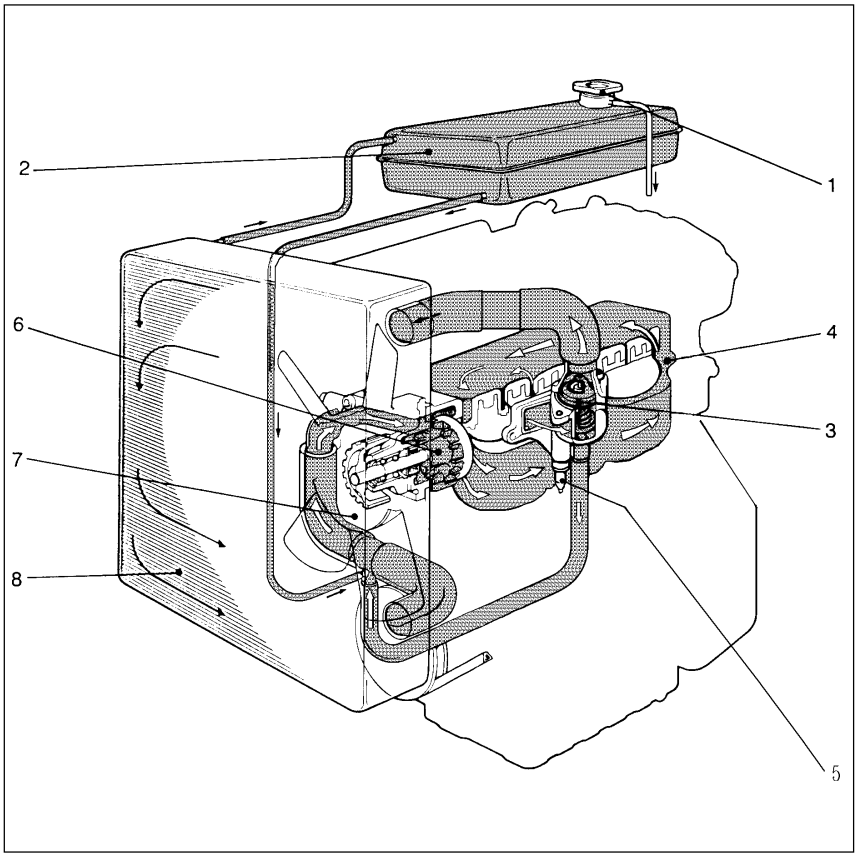
2.6 OPERATING PRINCIPLE FOR LUBRIFICATION

Ref.	*Description*
1	Pressure switch
2	Rocker-arm pin
3	Connecting rod big end pin
4	Oil filter cartridge
5	Main jurnal
6	Oil drain plug
7	Oil dipstick
8	Air vent
9	Oil refilling pump
10	Camshaft
11	Oil pressure regulating valve
12	Oil pump
13	Crankshaft
14	Oil suction filter



2.7 OPERATING PRINCIPLE FOR COOLING

Ref.	*Description*
1	Coolant refilling plug
2	Compensation tank
3	Thermostatic valve
4	Cylinder block
5	Liquid temperature monitoring thermostat
6	Circulating pump
7	Fan
8	Radiator

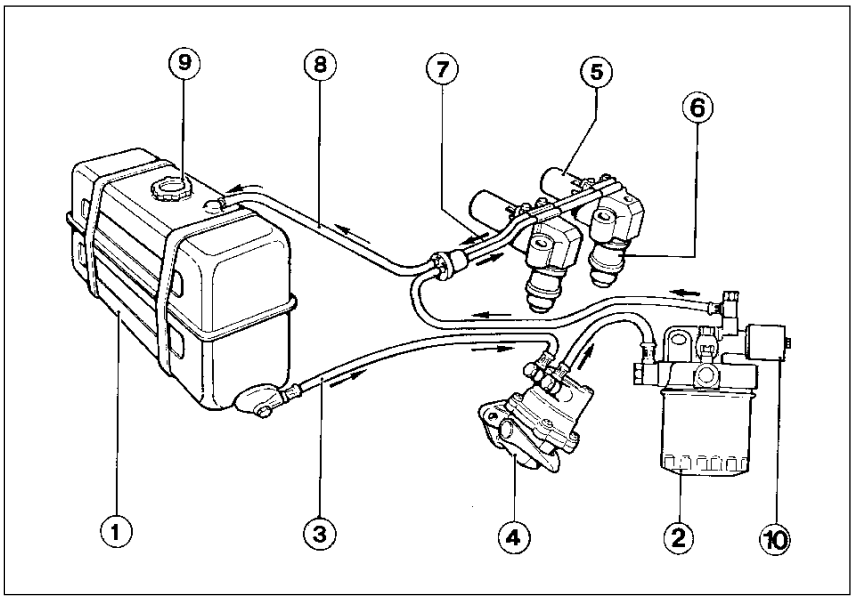


2.8 OPERATING PRINCIPLE FOR FUEL INJECTION

With mechanical supply pump

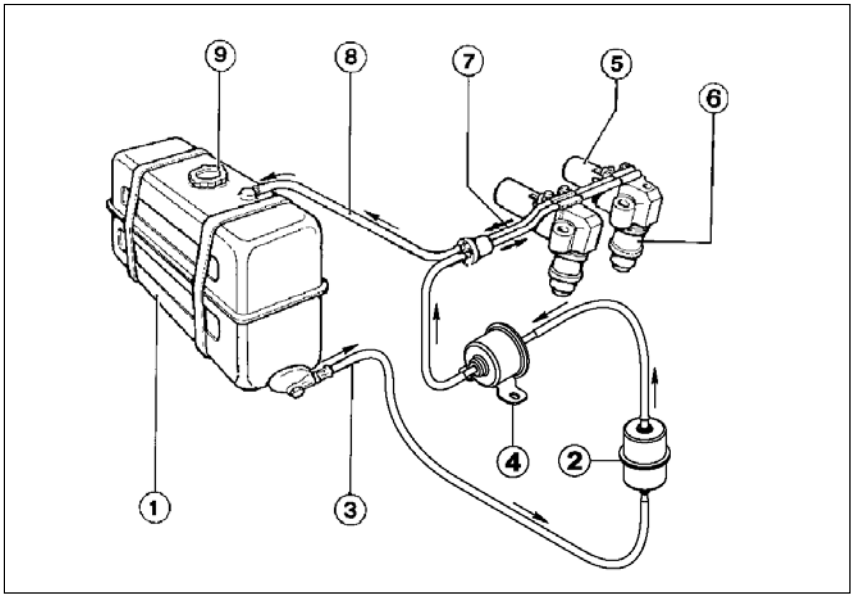
Ref.	*Description*
1	Tank
2	Fuel filter
3	Supply pipe
4	Supply pump
5	Injection pump
6	Injector
7	Fuel rail
8	Exhaust pipe
9	Plug
10	Solenoid valve

Note: ***the tank is supplied complete with filter on request.***



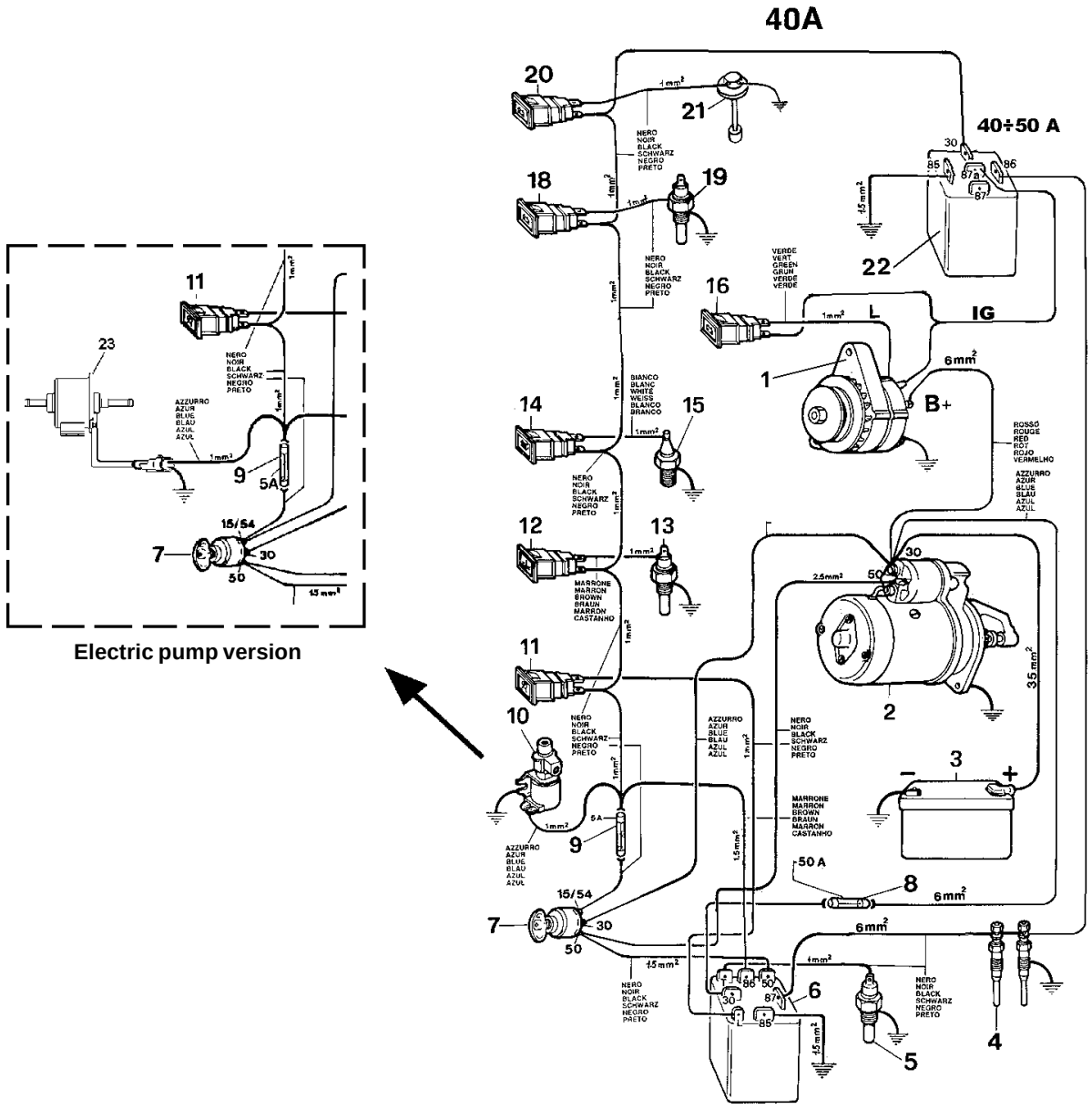
With electrical supply pump

Ref.	*Description*
1	Tank
2	Fuel filter
3	Supply pipe
4	Electrical supply pump
5	Pump
6	Injector
7	Fuel rail
8	Exhaust pipe
9	Plug



2.9 WIRING DIAGRAM

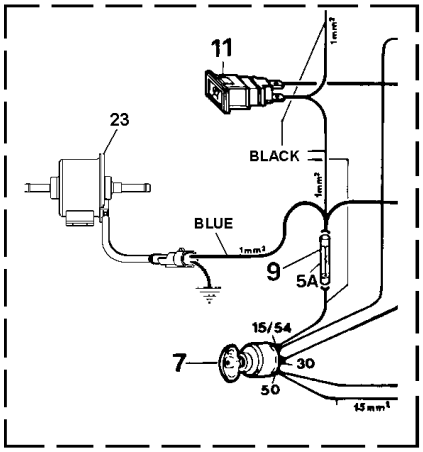
With external alternator



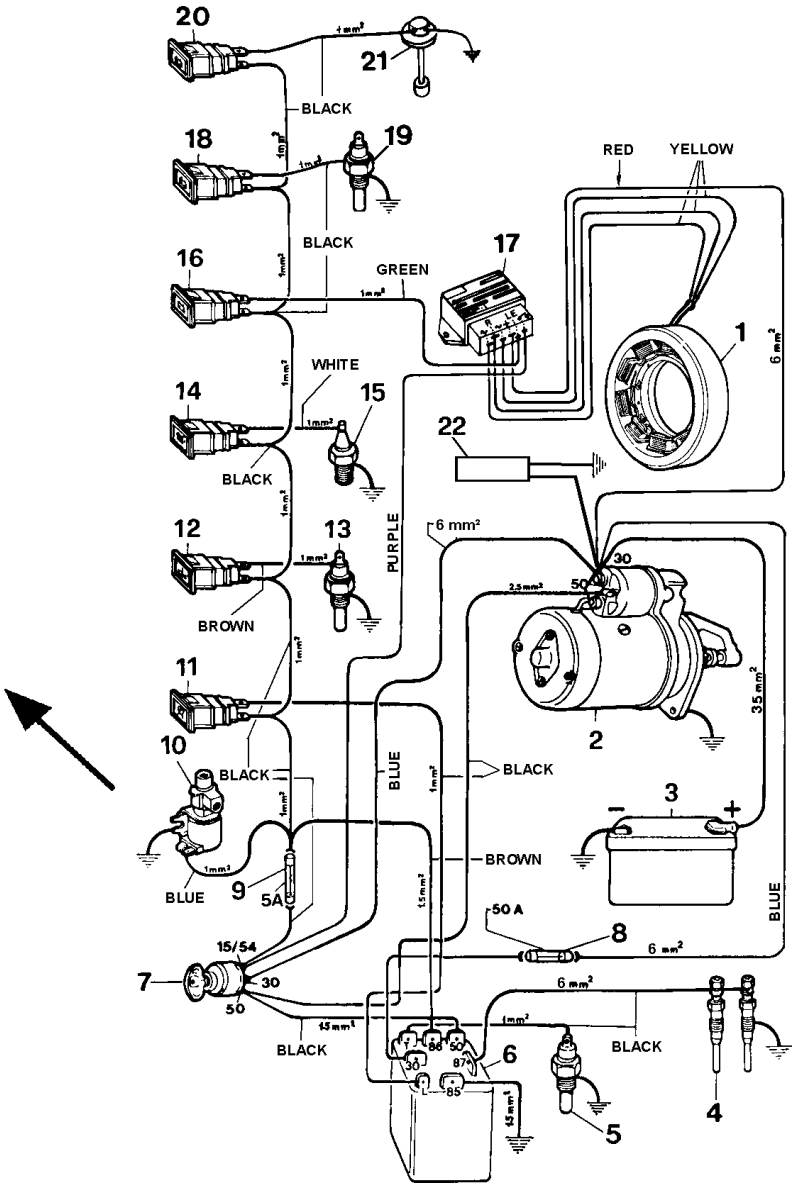
Ref.	Description
1	40A alternator
2	Starter motor
3	Battery (recommended 44Ah-210A-DIN)
4	Preheating glow plugs
5	Coolant temperature monitoring sensor
6	Glow plug pre-heating control box
7	Ignition switch
8	50A fuses
9	5A fuses
10	Electrostop device or electrical fuel lift pump
11	Glow plugs indicator
12	Coolant temperature indicator

Ref.	Description
13	Coolant thermostat indicator light
14	Engine oil preassure lamp
15	Oil preassure gauge
16	Battery load indicator
18	Coolant thermometer
19	Coolant thermomenter sensor
20	Fuel level light
21	Fuel level indicator
22	Relay (normally closed with a 3 second delay) 40÷50 A
23	Electrical fuel lift pump

With internal alternator



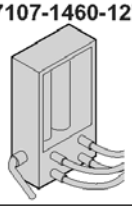
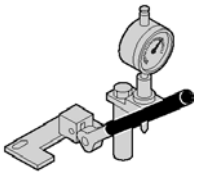
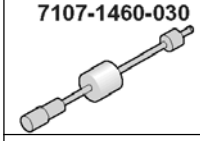
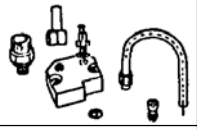
Electric pump version



Ref.	Description
1	40A alternator
2	Starter motor
3	Battery (recommended 44Ah-210A-DIN)
4	Preheating glow plugs
5	Coolant temperature monitoring sensor
6	Glow plug pre-heating control box
7	Ignition switch
8	50A fuses
9	5A fuses
10	Electrostop device or electrical fuel lift pump
11	Glow plugs indicator
12	Coolant temperature indicator

Ref.	Description
13	Coolant thermostat indicator light
14	Engine oil preassure lamp
15	Oil preassure gauge
16	Battery load indicator
17	Voltage regulator
18	Coolant thermometer
19	Coolant thermomenter sensor
20	Fuel level light
21	Fuel level indicator
22	25 V - 10000 µF condensator
23	Electrical fuel lift pump

2.10 SPECIAL TOOLS AND EQUIPMENT FOR MAINTANANCE

Serial number	*Description*	*Serial number*	*Description*
7107-1460-127 	Instrument for balancing injection pump delivery	7107-1460-048 	Tool for lowering injection advance control valve
7107-1460-030 	Precombustion chamber extractor	7107-1460-074 	Equipment for injection advance control and injector calibration
7107-1460-029	Pin wrench for ring nut on pump/ injector pumping element	7107-1460-051	Driving shaft clamping tool
7107-1460-027	Precombustion chamber pin wrench	7107-1460-031	Pivot pin precombustion chamber
7107-1460-047	Tool for mounting intake/exhaust valve guide gasket	7271-1460-049	Tool for adjusting timing belt tension

2.11 TABLE FOR TIGHTENING TORQUES

The table shows the tightening torques for standard screws and the main components.

Tightening torques are provided again, along with method and sequence, in the instructions for assembling components and/or assemblies.

Tightening torques for standard screws (coarse thread)

Resistance class (R)								
Quality / Dimensions	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
Diameter	R>400N/mm²		R>500N/mm²		R>600N/mm²	R>800N/mm²	R>1000N/mm²	R>1200N/mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M3	0,5	0,7	0,6	0,9	1	1,4	1,9	2,3
M4	1,1	1,5	1,4	1,8	2,2	2,9	4,1	4,9
M5	2,3	3	2,8	3,8	4,5	6	8,5	10
M6	3,8	5	4,7	6,3	7,5	10	14	17
M8	9,4	13	12	16	19	25	35	41
M10	18	25	23	31	37	49	69	83
M12	32	43	40	54	65	86	120	145
M14	51	68	63	84	101	135	190	230
M16	79	105	98	131	158	210	295	355
M18	109	145	135	181	218	290	405	485
M20	154	205	193	256	308	410	580	690
M22	206	275	260	344	413	550	780	930
M24	266	355	333	444	533	710	1000	1200
M27	394	525	500	656	788	1050	1500	1800
M30	544	725	680	906	1088	1450	2000	2400

Tightening torques for standard screws (fine threads)

Resistance class (R)								
Quality / Dimensions								
Diameter	R>400N/mm²		R>500N/mm²		R>600N/mm²	R>800N/mm²	R>1000N/mm²	R>1200N/mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M 8x1	10	14	13	17	20	27	38	45
M 10x1	21	28	26	35	42	56	79	95
M 10x1,25	20	26	24	33	39	52	73	88
M 12x1,25	36	48	45	59	71	95	135	160
M 12x1,5	38	45	42	56	68	90	125	150
M 14x1,5	56	75	70	94	113	150	210	250
M 16x1,5	84	113	105	141	169	225	315	380
M 18x1,5	122	163	153	203	244	325	460	550
M 18x2	117	157	147	196	235	313	440	530
M 20x1,5	173	230	213	288	345	460	640	770
M 20x2	164	218	204	273	327	436	615	740
M 22x1,5	229	305	287	381	458	610	860	1050
M 24x2	293	390	367	488	585	780	1100	1300
M 27x2	431	575	533	719	863	1150	1600	1950
M 30x2	600	800	750	1000	1200	1600	2250	2700

Tightening torques for main components

Description	Diameter x thread	Tightening torque (Nm)
Injector pump connecting rod	M 3 spéc.	1,2
Aluminium connecting rod	8x1	35
Preheating glow plugs	12x1,25	25
Rocker-arm cover	6x1	9
Crankcase (screws for fixing crankshaft)	M 10	30
Crankcase (screws for fixing engine block)	M 6	10
Screw for speed governor bearing support cover	M 6	10
Preheating glow plugs cable nuts	5x0,8	5
Fuel supply pump nuts	8x1,5	24
Nut for synchronous timing belt pulley	M 10	40
Injector pump nut	8x1,25	20
Rocker arm support nuts	10x1,5	40
Fuel pump control eccentric	10x1,25	80
Oil sealing ring flange screws (flywheel side)	M 6	12
Precombustion chamber ring nut	30x1,5	180
Governor tinkage adjustment pin	6x1	7
Crankshaft pulley screw (timing belt side)	16x1,5 gauche	360
Camshaft pulley screw	10x1,25	80
Oil pressure switch	12x1,5	25
Oil plug	12x1,5	40
Cylinder head screws		40 (1)
Injector pump head screws	TCEI 4x1,5	4
Flywheel screws	10x1,5	80
Coolant thermostat / Control unit sensor		30
Control unit temperature sensor		30

(1) For more detailed information see “Assembling the cylinder head”

2.12 TABLE OF SEALANTS

Area of application	*Sealant*
Fuel rail attachment	Loctite 638
Oil filter cartridge union (M 20X1,5)	Loctite 601
Camshaft bearing screw (M 6)	Loctite 270
Stud bolt for tightening pulley (M 10)	Loctite 601
Cylinder head plug (ø 18)	Loctite 510
Engine and engine block cylinder head plug (ø 30)	Loctite 510

2.13 ROUTINE ENGINE MAINTENANCE

		After the first 500 Km	REGULARITY KM (per 1000 Km)																			
			5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
PROCEDURE	DETAIL																					
CLEANING	Pump injectors					■				■				■				■				■
	Radiator fan					■				■				■				■				■
CHECK	Valve and rocker arm clearance					■				■				■				■				■
	Engine oil	EVERY 2500 Km																				
	Solenoid valve operation					■				■				■				■				■
	Oil vapor recovery					■				■				■				■				■
	Fuel pipe and connections	■				■				■				■				■				■
	Coolant	■				■				■				■				■				■
	Alternator belt	■		■		■				■		■		■		■		■				■
	Timing belt	EVERY 25000 Km																				
	Alternator																					
CHANGE	Air filter element			■		■		■		■		■		■		■		■		■		■
	Engine oil	■	EVERY 5000 Km																			
	Oil filter	■																				
	Fuel filter			■		■		■		■		■		■		■		■		■		■
	Coolant											■										■
	Alternator belt							■						■						■		
	Timing belt	EVERY 50000 Km (or at every disassembly)																				
	Fuel pipes	EVERY 4 years																				

Notes :

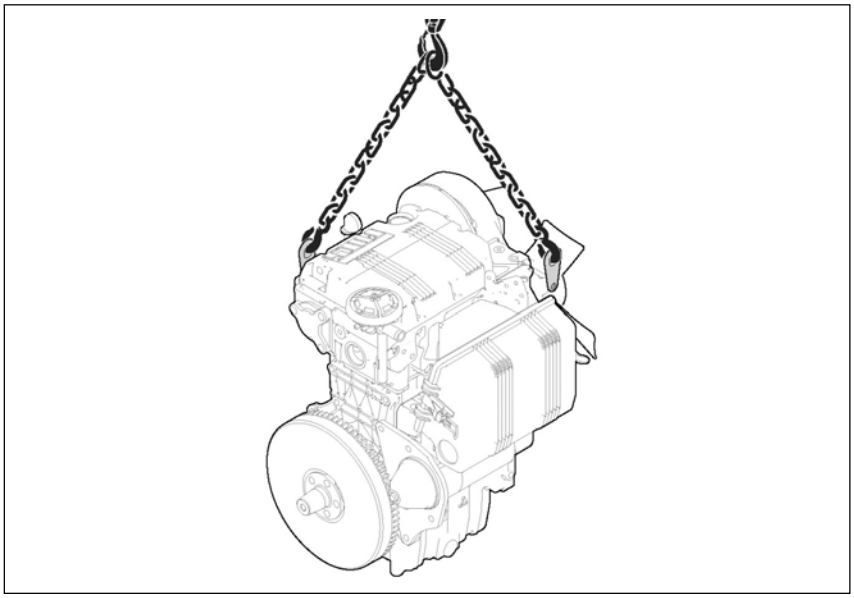
3.1 LOOKING FOR MALFUNCTIONS

The following information is provided to help identify and correct any irregularities and malfunctions that may arise during use.

	Probable cause	Problem										
		Engine does not start	*Engine starts and then stops*	*Does not accelerate*	*Inconsistent rpm*	*Black smoke*	*White smoke*	*Low oil preassure*	*Oil consumption too high*	*Consommation huile en excès*	*Oil and condensation dripping from the exhaust*	*Coolant overheats*
FUEL CIRCUIT	Clogged pipes	■										
	Clogged fuel filter	■	■	■	■							
	Air in the fuel circuit	■	■	■	■		■					
	Clogged tank breather	■	■	■								
	Faulty fuel pump	■	■		■				■			
	Blocked injector	■				■						
	Blocked injection pump valve	■										
	Injector not adjusted					■						
	Excess leaking in the plunger				■	■			■			
	Jammed injection pump delivery control	■		■	■							
	Wrong injection pump delivery setting			■		■						
LUBRIFICATION	High oil level				■		■			■		■
	Blocked pressure relief valve							■				
	Worn oil pump							■				
	Air in the oil intake pipe							■				
	Faulty pressure gauge or switch							■				
	Clogged oil suction hose							■				
ELECTRICAL SYSTEM	Burnt fuse on pre-heating glow plugs	■										
	Failure in glow plugs control unit	■										
	Discharged battery	■										
	Inefficient or wrong cable connection	■										
	Faulty ignition switch	■										
	Faulty starter motor	■										
MAINTENANCE	Air filter clogged	■		■		■				■		
	Excessive idle operation						■				■	
	Incomplete running-in						■					
	Overloaded engine	■	■	■		■				■		■
	Clogged cooling circuit					■						■
	Slack or broken fan control belt											■
ADJUSTMENTS / REPAIRS	Advance injection											
	Delayed injection	■				■	■					■
	Incorrect governor tinkage adjustment	■			■							
	Broken or loose governor spring		■	■								
	Low idle setting		■			■				■	■	
	Worn or stuck piston rings	■					■			■	■	
	Worn or scored cylinders						■			■	■	■
	Worn valve guides						■			■	■	
	Valves stuck	■										
	Worn crankshaft/connecting rod bearings							■				
	Non-sliding speed governor leverage	■	■	■	■							
	Driving shaft not turning freely					■						
	Damaged head gasket	■							■			■
	Slack pump/injector control rod	■										
	Incorrect pump/injector delivery balancing	■										

4.1 HANDLING AND LIFTING

- Secure the engine using a lifting device (lifting beam) of suitable capacity.
- Hook the lifting device to the points indicated in the drawing.
- Before lifting, check the load's centre of gravity.



Important

The dimensions of the brackets on the fastening points have been specially conceived to lift the engine and have not been tested for lifting additional weights. Do not lift the engine using different methods from those described. Non-observance of this requirement will invalidate the insurance warranty from any damages caused in this way.

4.2 STORING THE ENGINE (UNINSTALLED)

- If the engine is not to be used for extensive periods, check the surroundings and the type of packaging and make sure that they are suitable for correct storage.
  If necessary, cover the engine with a protective sheet.

- Avoid storing the engine directly on the ground or in an environment that is humid, exposed to bad weather or close to sources of danger, including less visible ones, such as high-voltage power lines etc.

- If the engine is not to be used for more than 1 month, it is necessary to apply the protective measures that are valid for 6 months (see "Protective treatment (first 6 months of inactivity)")

- If, after the first 6 months, the engine is still not to be used, it is necessary to carry out a further measure to extend the protection period (see "Protective treatment (after 6 months of inactivity)").

4.3 STORING THE ENGINE (INSTALLED)

If the engine has been installed on a machine and is not due to be used for extensive periods, it is necessary to carry out a few maintenance measures in order to ensure it remains efficient and to protect its components. If the engine is installed on the machine and is not to be used for short periods of time, the following measures must be carried out:

- Check the condition of the electrical contacts and protect them, if necessary, using an anti-rust spray.
- Disconnect the battery.
- Empty the fuel tank to prevent the risk of fire.
- Remove the key from the dashboard and put it in a safe place to avoid acts of vandalism.
- Lock the cabin and the cowls to prevent strangers getting access.

If the engine is not to be used for more than 1 month, it is necessary to apply protective measures that are valid for 6 months (see "Protective treatment").
If, after the first 6 months, the engine is still not to be used, it is necessary to carry out a further measure to extend the protection period (see "Protective treatment").

4.4 PROTECTIVE TREATMENT

1- Check that the engine oil and coolant are up to level.
2 - Start the engine and keep idle at minimum speed for 15 minutes.
3 - Switch off the engine and leave to cool.
4 - Take out the lubricant
5 - Fill the casing with AGIP RUSTIA C protective oil
6 - Empty the fuel tank completely.
7 - Replace fuel filter.
8 - Fill the fuel tank with a mixture made up of 10% AGIP RUSTIA NT protective oil and 90% fuel.
9 - Release the air from the fuel supply circuit.
10 - Start the engine and check for fuel leaks.
11 - Start the engine and bring to ¾ of the maximum speed for 5-10 minutes.
12 - Switch off the engine.
13 - Spray SAE 10W oil on the exhaust and intake manifolds.
14 - Close all openings to prevent foreign bodies from entering.
15 - Thoroughly clean all external parts of the engine using suitable products.
16 - Treat non-painted parts with protective products (AGIP RUSTIA 100/F).
17 - Loosen the alternator-fan belt.
18 - If necessary, cover the engine with a protective sheet.

Important

After a year of engine inactivity, the coolant loses its properties and must be replaced

4.5 PREPARING THE ENGINE FOR OPERATION (UNINSTALLED)

After a period of inactivity and before installing and running the engine, it is necessary to carry out a few measures in order to ensure that it runs at maximum efficiency.

1 - Remove the protective treatment.
2 - Remove any blockages from the exhaust and intake ducts.
3 - Use a cloth soaked in degreasing product to remove the external protective treatment.
4 - Remove the intake manifold.
5 - Inject lubrication oil (no more than 2 cm^3) into the valves and replace the intake manifold.
6 - Adjust the alternator-fan belt tension.
7 - Turn the flywheel manually to check the movement of the mechanical parts.
8 - Start the engine and run at ¾ of the maximum speed for 5-10 minutes.
9 - Switch off the engine.
10 - Remove the protective oil to replace with engine oil.
11 - Introduce new oil (see “Table of lubricants”) up to the correct level marked on the dipstick.
12 - Check the filters for aging (air, oil, fuel) and, if necessary, replace them with original spares.

Important

Over time, a number of engine components and lubricants lose their properties, even when the engine is not in use, and so it is important to consider whether they need replacing, based not only on the number of hours of use, but also on age and wear.

13 - Install the engine onto the machine and make the necessary connections and unions.
14 - Make sure that electrical contacts are intact and efficient.
15 - Check that the engine oil and coolant are up to level.
16 - Start the engine and keep at minimum speed for a few minutes.
17 - Check for leaks and, if necessary, find and eliminate the cause.
18 - Switch off the engine.

4.6 PREPARING THE ENGINE FOR OPERATION (INSTALLED)

After a period of inactivity and before installing and running the engine, it is necessary to carry out a few measures in order to ensure that it runs at maximum efficiency.

1 - Use a cloth soaked in degreasing product to remove the external protective treatment.

2 - Adjust the alternator-fan belt tension.

3 - Make sure that electrical contacts are intact and efficient.

4 - Check the filters for aging (air, oil, fuel) and, if necessary, replace them with original spares.

Important

Over time, a number of engine components and lubricants lose their properties, even when the engine is not in use, and so it is important to consider whether they need replacing, based not only on the number of hours of use, but also on age and wear.

5 - Check that the engine oil and coolant are up to level.

6 - Start the engine and keep at minimum speed for a few minutes.

7 - Check for leaks and, if necessary, find and eliminate the cause.

8 - Switch off the engine.

5.1 RACCOMENDATIONS FOR REMOVING THE ASSEMBLIES

- Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.
- This chapter describes procedures for removing assemblies and/or individual components, in order to carry out work on specific parts of the engine.
- See the chapter entitled "Overhauls and tuning" for operations involving checks, overhauls and tuning of assemblies and/or components.
- See the chapter entitled "Installation of assemblies" for operations involving the installation of assemblies and/or components.

Important

To locate specific topics, the reader should refer to the index.

- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.

5.2 REMOVING THE EXHAUST AND INTAKE MANIFLODS

5.2.1 Disassembling the intake manifold

"Panel" filter

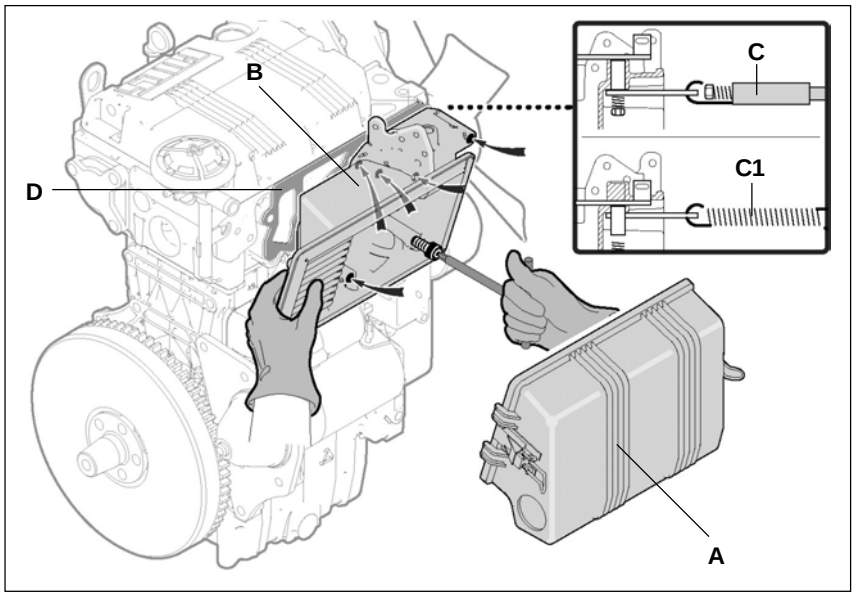
1 - Remove the cover **(A)**.

2 - Remove the intake manifold **(B)**

3 - Unhook the minimum-maximum device **(C)** or the spring **(C1)**.

4 - Remove the gasket **(D)**.

5 - Close the openings and ducts to prevent foreign bodies from entering.



"Cartridge" filter

1 - Remove the cover **(E)**.

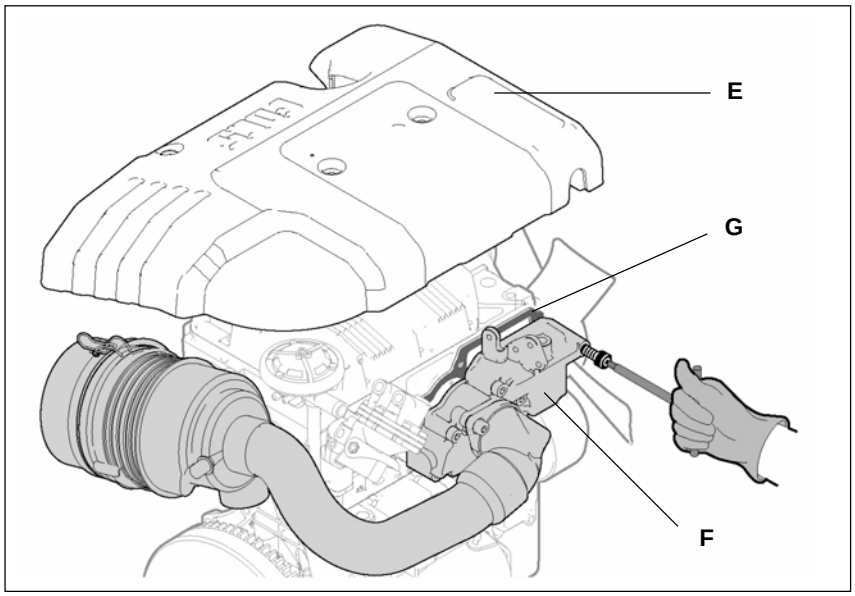
2 - Disconnect the intake and air vent pipes.

3 - Remove the intake manifold **(F)**.

4 - Unhook the minimum-maximum device or the spring.

5 - Remove the gasket **(G)**.

6 - Close the openings and ducts to prevent foreign bodies from entering.



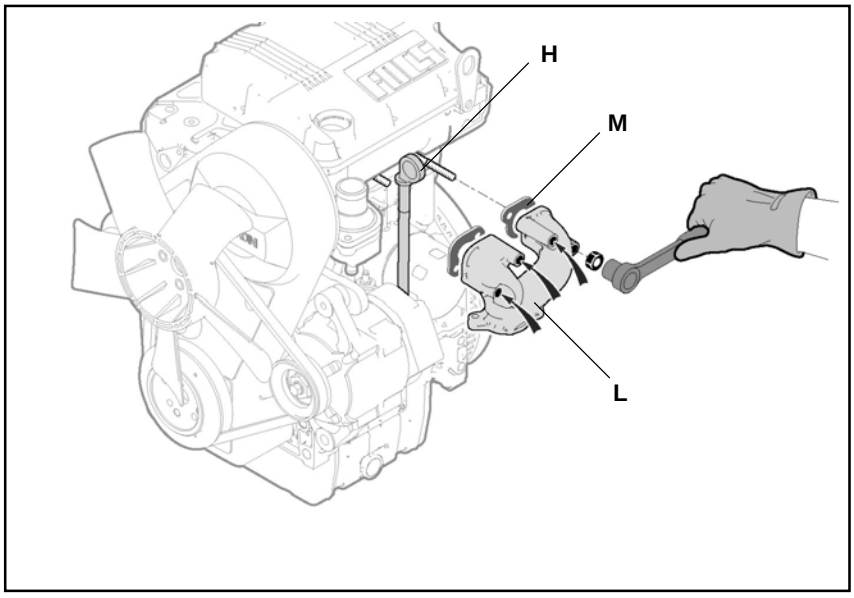
5.2.2 Disassembling the exhaust manifold

1 - Remove the dipstick tube **(H)**.

2 - Remove the exhaust manifold (**L**).

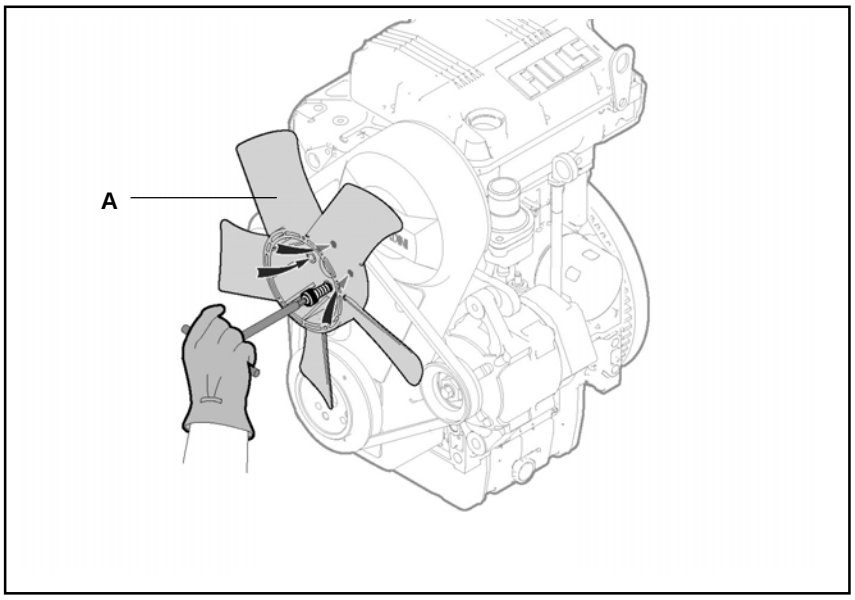
3- Remove the gaskets (**M**).

4 - Close the openings and ducts to prevent foreign bodies from entering.



5.3 REMOVING THE COOLING FAN BELT DRIVE

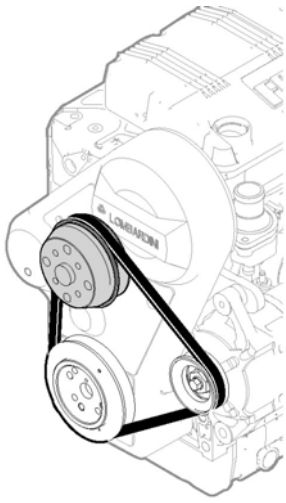
1 - Remove the cooling fan **(A)**.



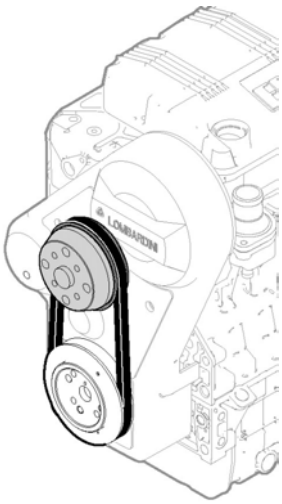
Important

The cooling fan belt drive comes in more than one version: with external or internal alternator.

with internal alternator



with external alternator

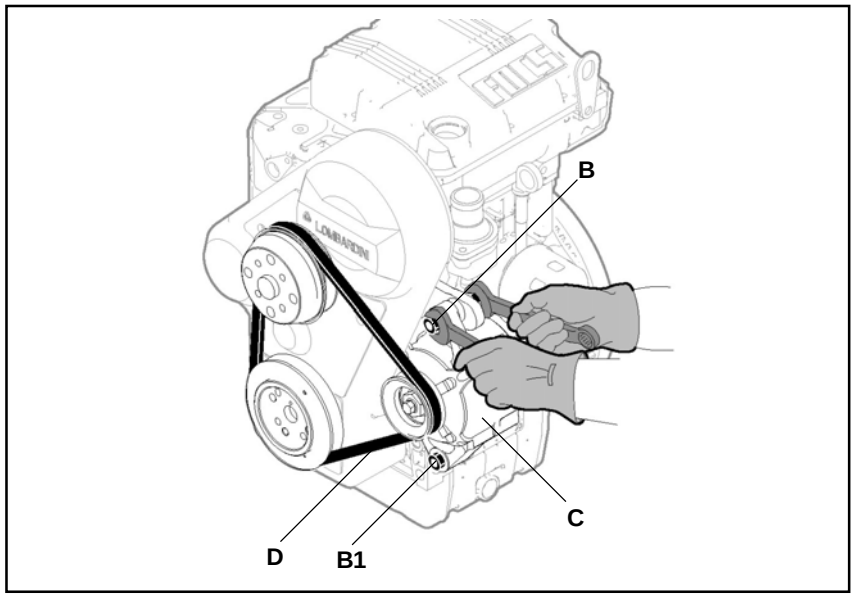


5.3.1 Disassembling the cooling fan belt (with external alternator)

1 - Loosen the nuts **(B - B1).**

2 - Loosen the belt **(D)** by adjusting the alternator **(C)** manually.

3 - Remove the belt **(D)**.



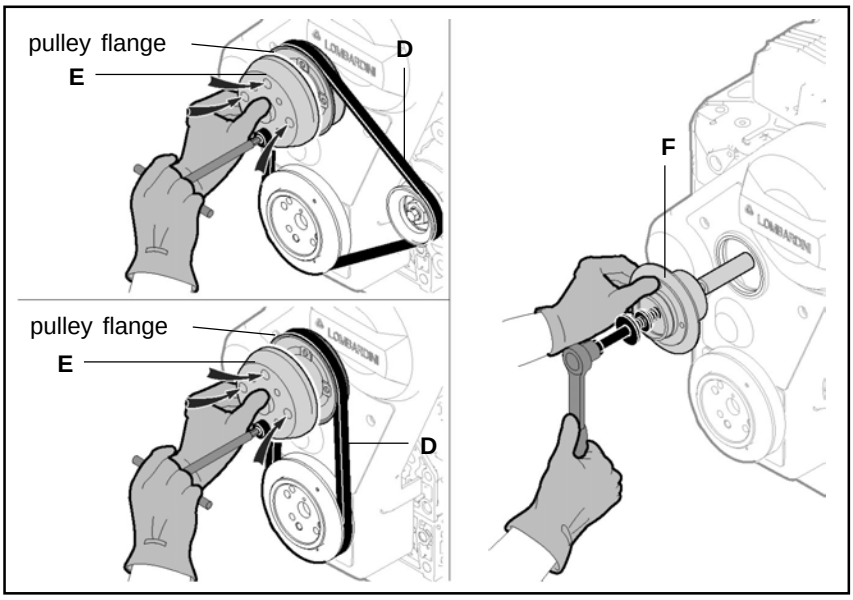
4 - Remove the hub **(E)** and flange.
5 - Remove the pulley **(F),** washers and spacer.

5.3.2 Disassembling the cooling fan belt (with internal alternator)

1 - Remove the hub **(E)** and flange.

2 - Remove the belt **(D)**.

3 - Remove the pulley **(F)**, washers and spacer.



5.4 REMOVING THE TIMING BELT

5.4.1 Disassembling the timing belt casing

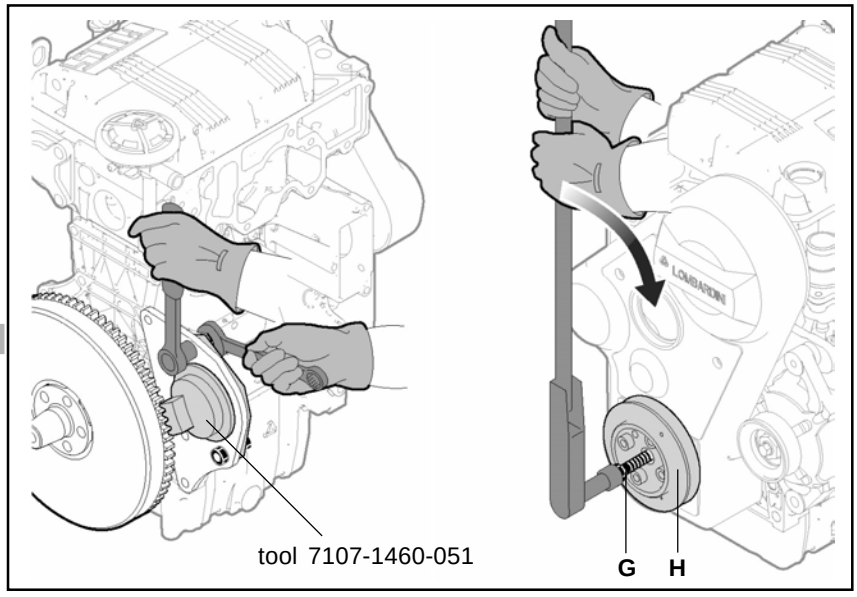
1 - Disassemble the starter motor.

2 - Install tool “7107-1460-051” to inhibit rotation of the crankshaft.

3 - Loosen the screw **(G)**.

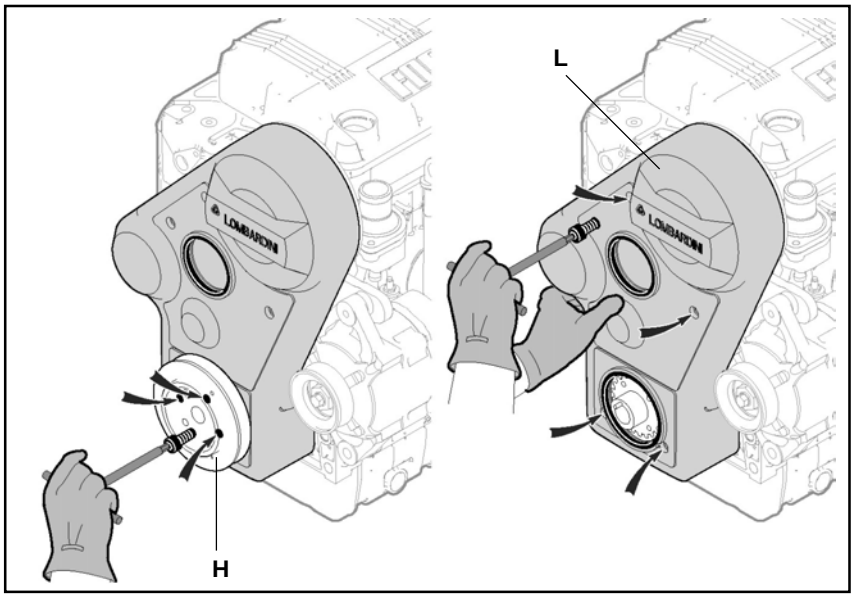
Caution - Warning

The screw is left-handed. Turn clockwise to unscrew.



4 - Loosen the screws and remove the pulley **(H)**.

5 - Remove the casing **(L)**.



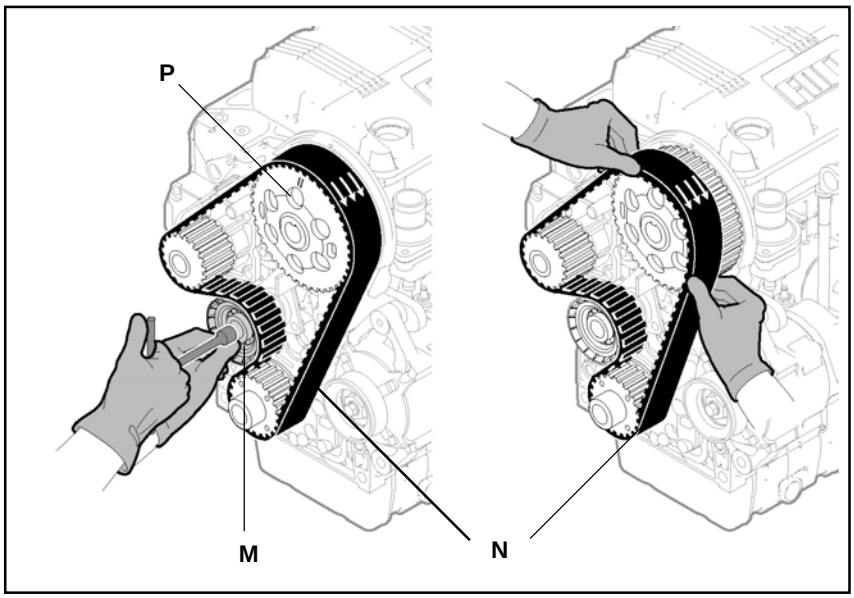
5.4.2 Disassembling the timing belt

1 - Twist the pulley nut **(M)** to fully loosen the belt **(N)**.

2 - Remove the belt **(N)**, working it away in sequence first from the pulley and **(P)** and then from the others.

Important

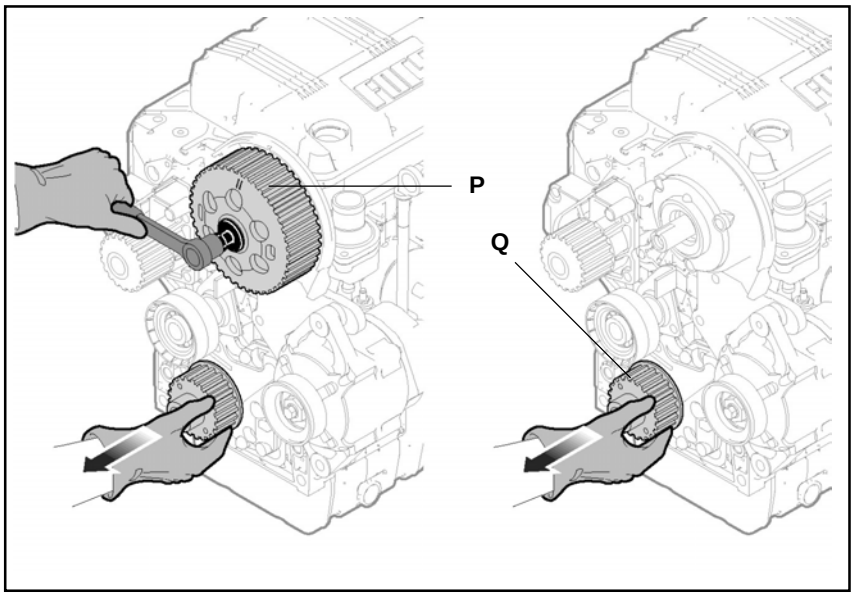
The timing belt must always be replaced with an original spare part whenever it is removed.



5.4.3 Disassembling the pulleys (camshaft and crankshaft)

1 - Remove the pulley **(P)**.

2 - Remove the pulley **(Q)**.



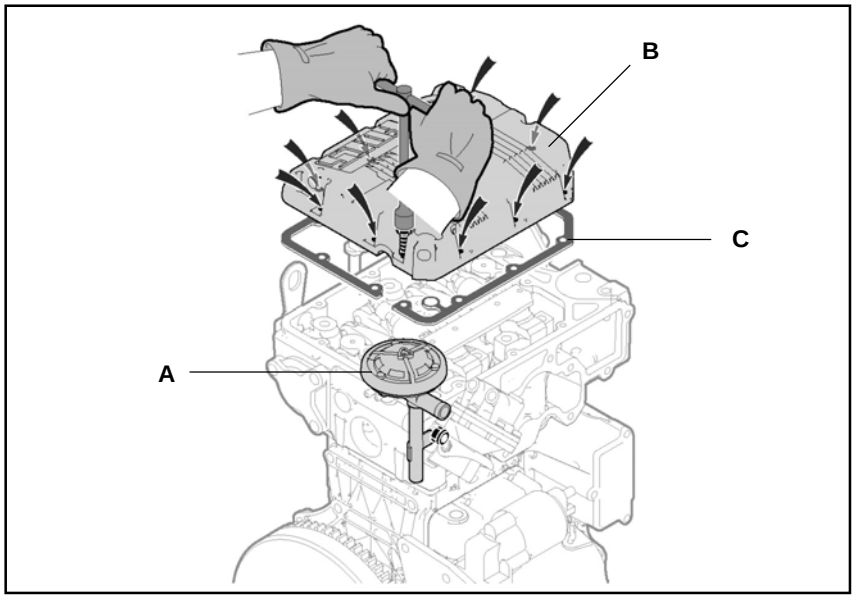
5.5 REMOVING THE CYLINDER HEAD

5.5.1 Disassebling the rocker arm cover

1 - Remove the negative-pressure vent valve **(A)**.

2 - Remove the rocker arm cover **(B)**.

3 - Remove the gasket **(C)**.



5.5.2 Disassebling the rocker arms

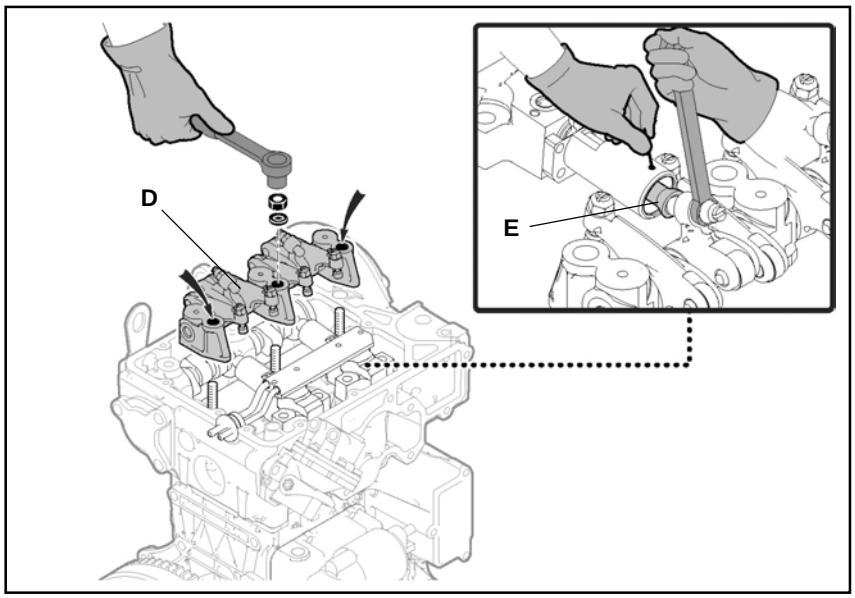
1 - Press the rocker arm to fully push the drive rod down **(E)**.

2 - Introduce a pin to interrupt the injector stroke in order to be able to extract the drive rod.

3 - Let go of the rocker arm and remove the drive rod.

4 - Repeat the same operation on the other injector.

5 - Remove the rocker arm pin and support **(D).**



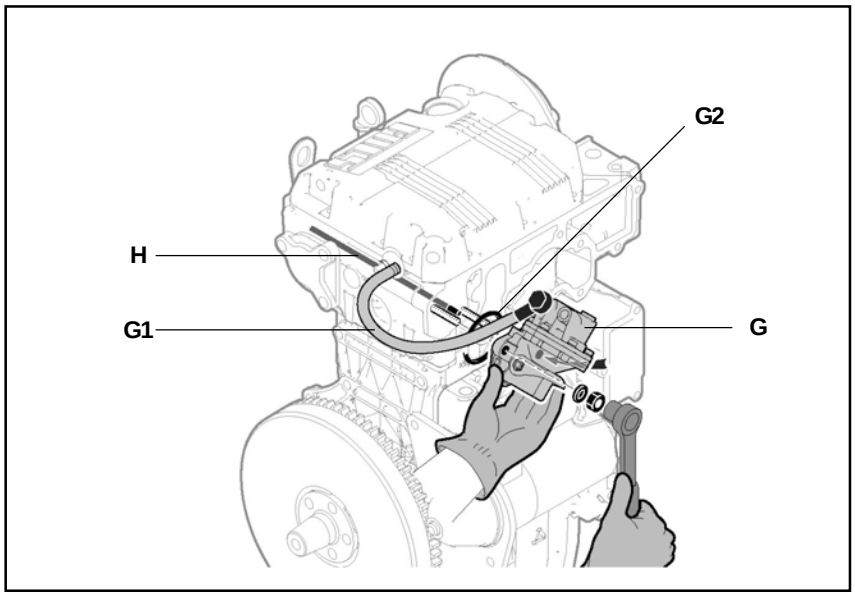
5.5.3 Disassebling the fuel pump

1 - Disconnect the supply pipe **(G1)** from the union.

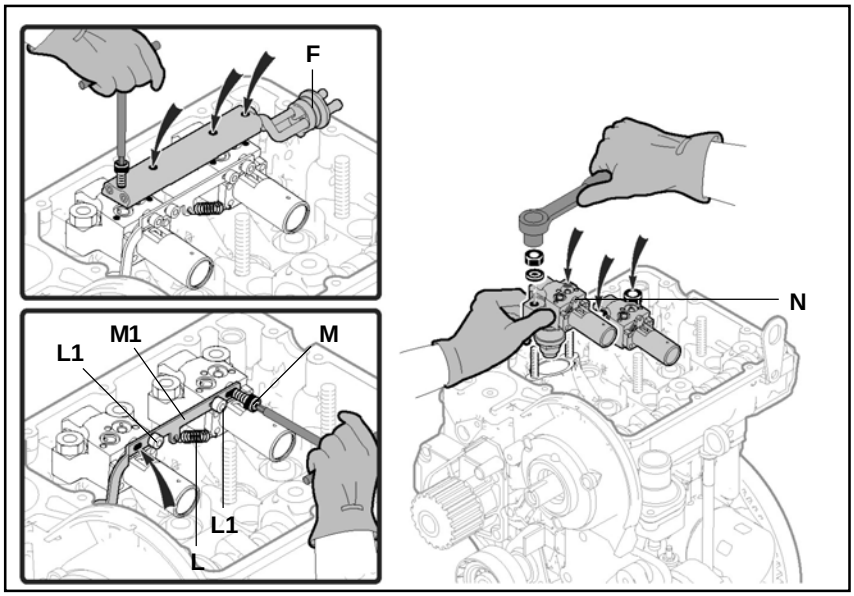
2 - Remove the supply pump **(G)**.

3 - Remove the O-ring **(G2)**.

4 - Extract the drive rod **(H)**.



5.5.4 Disassembling the injection-pumps



1 - Remove the fuel rail **(F)**.

Important

Make sura that the injector gaskets remain in position.

2 - Unhook the spring **(L)**.

Important

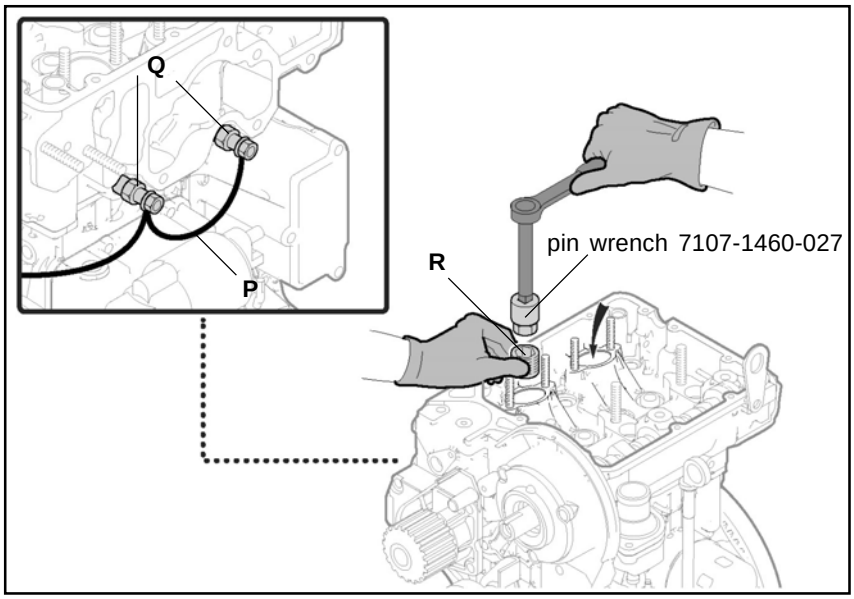
If injector pumps are to be used during installation, do not loosen the screws (LI) in order to not balance injector pump deliveries during tuning.

3 - Unscrew the screws **(M)**.

4 - Remove the connecting rod **(M1)**.

5 - Dismount the injection-pumps **(N)**.

5.5.5 Disassembling precombustion chamber

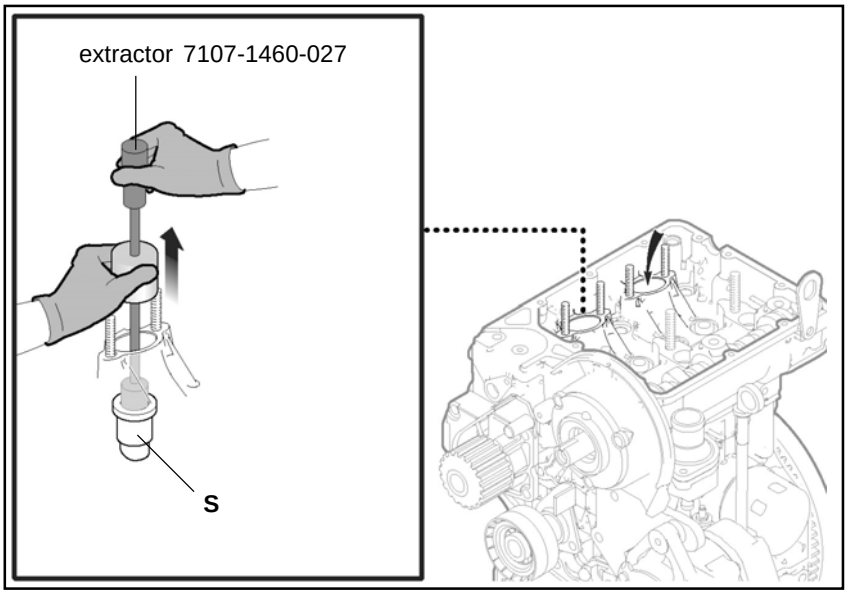


1 - Disconnect the electric cable **(P)**.

2 - Remove the preheating glow plugs **(Q)**.

3 - Unscrew the ring nut **(R)** using the special pin wrench “7107-1460-027”.

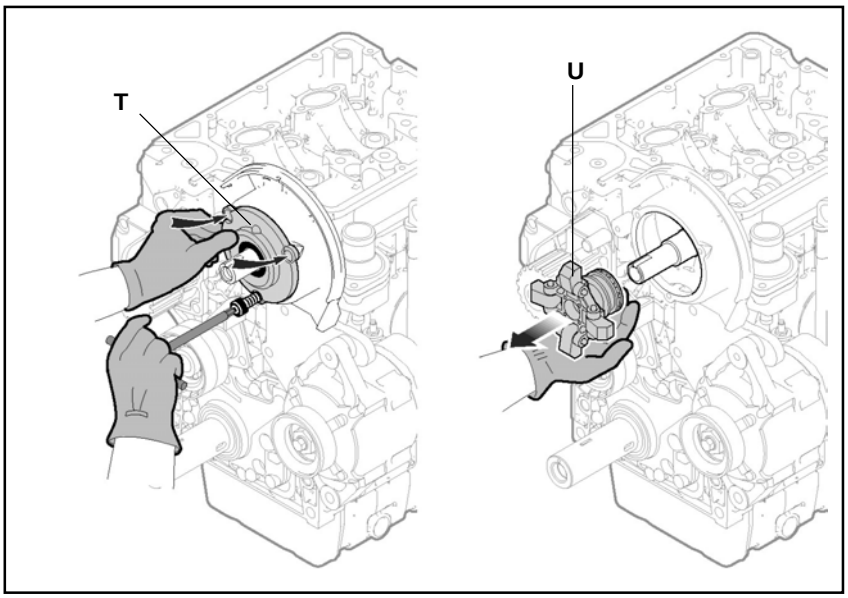
4 - Screw the extractor “7107-1460-030” onto the precombustion chamber **(S)** and remove it.



5.5.6 Disassembling the speed governor and flow limiter

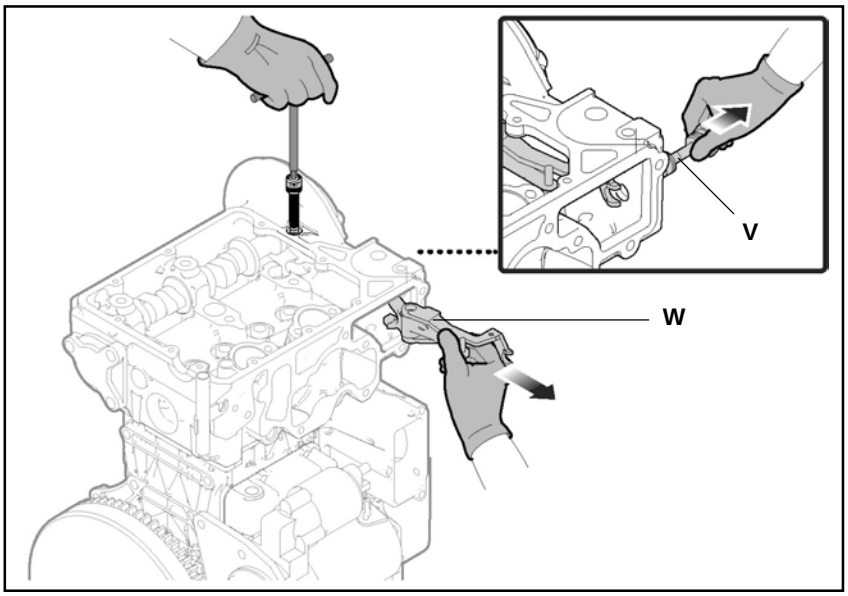
1 - Remover the cover **(T**).

2 - Extract the weights assembly **(U)** from the camshaft.



3 - Remove the fuel flow limiter **(V).**

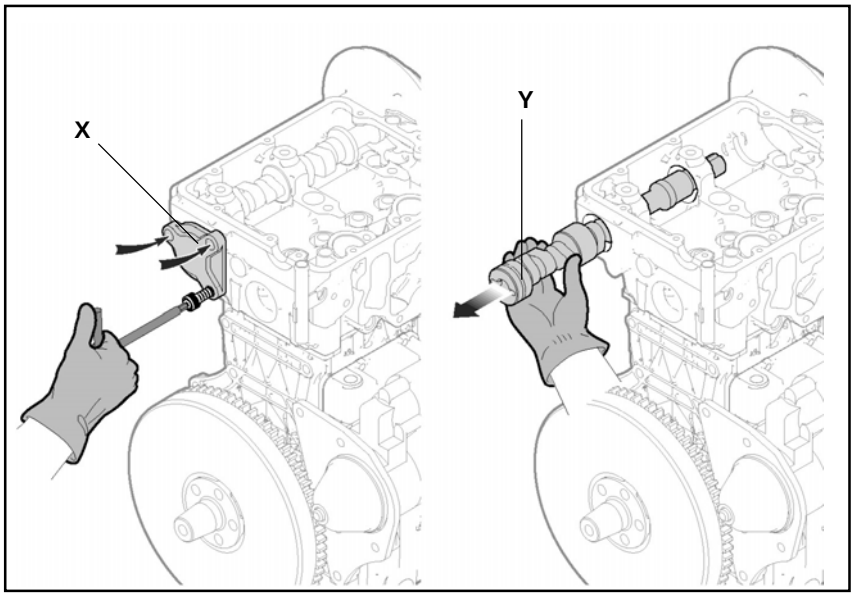
4 - Unscrew the pin and extract the governor tinkage adjustment pin **(W)**.



5.5.7 Disassembling the camshaft

1 - Remove the cover **(X)**.

2 - Extract the camshaft **(Y)** from the cylinder head.



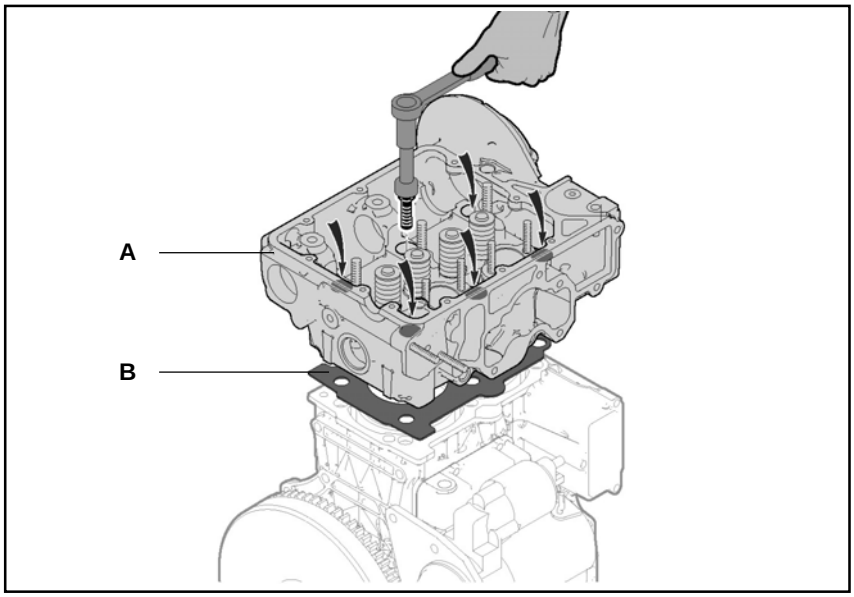
Important

Make sure the drive rod has been removed and rotate the camshaft gently to remove it easily.

5.5.8 Disassembling the cylinder head

1 - Remove the cylinder head **(A)**.

2 - Take off the gasket **(B)**.



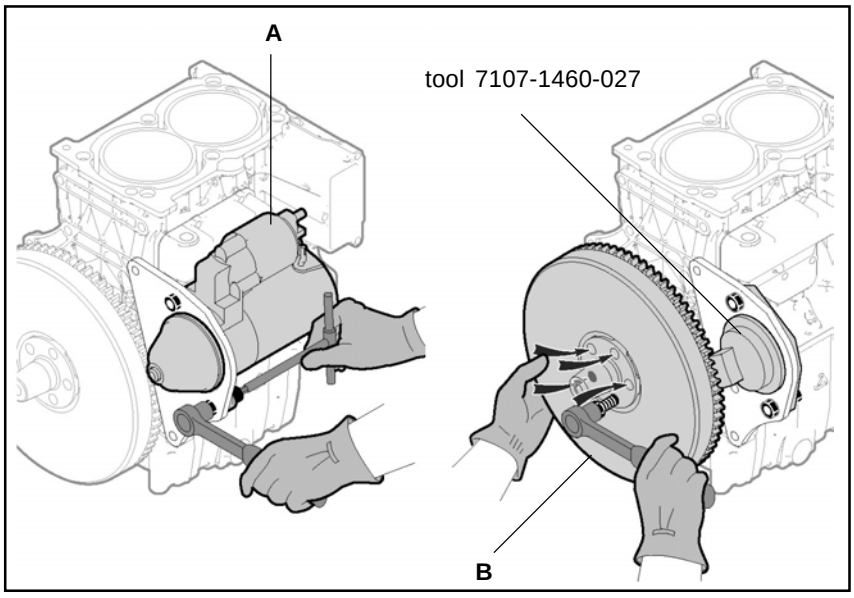
5.6 REMOVING THE CRANK GEAR AND CRANKCASE

5.6.1 Disassembling the flywheel

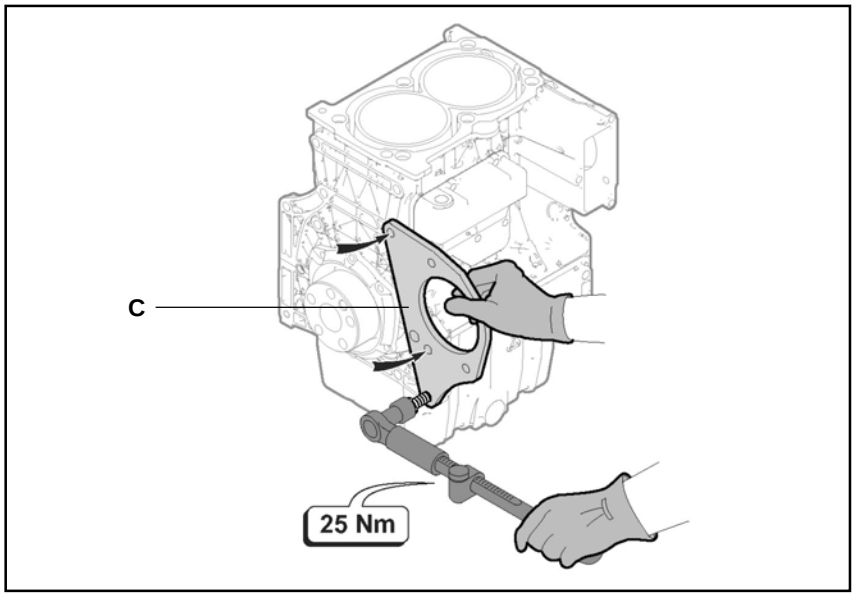
1 - Disassemble the starter motor **(A)**.

2 - Install tool "7107-1460-051" to inhibit rotation of the crankshaft.

3 - Remove the flywheel **(B)**.



4 - Remove the support **(C)**.

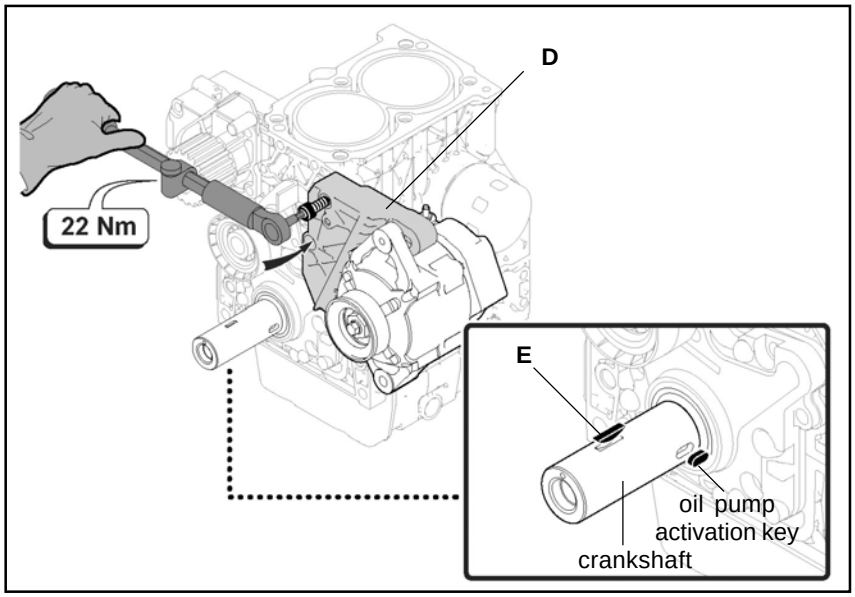


5.6.2 Disassembling the oil pump

1 - Remove the flange **(D)**.

2 - Extract the key **(E)** from the crankshaft.

3 - Bring piston number one (flywheel side) to the top dead centre, with the oil pump activation key in line with break in the flange, in order to be able to remove it.

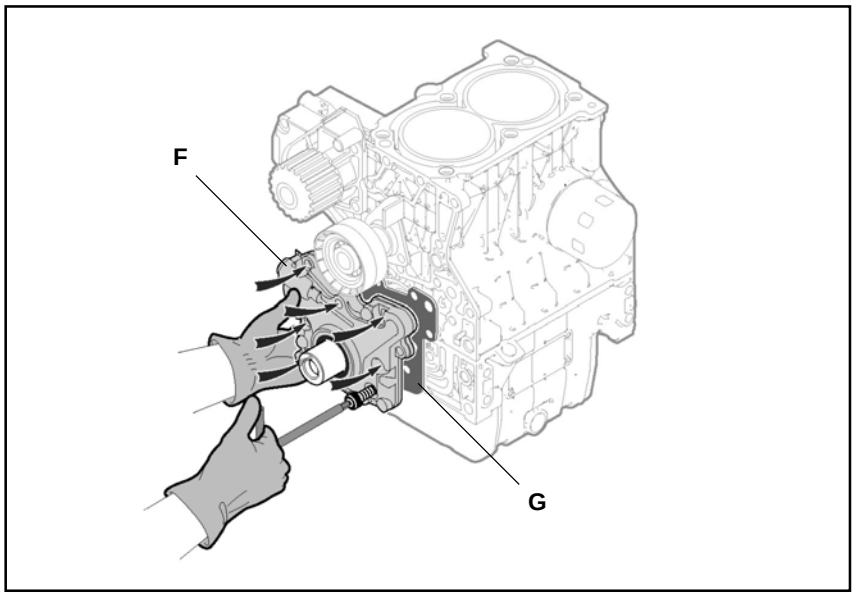


Important

You should in no way try to force removal of the pump, if its activation key is not lined up with the break in the flange.

4 - Remove the oil pump **(F)**.

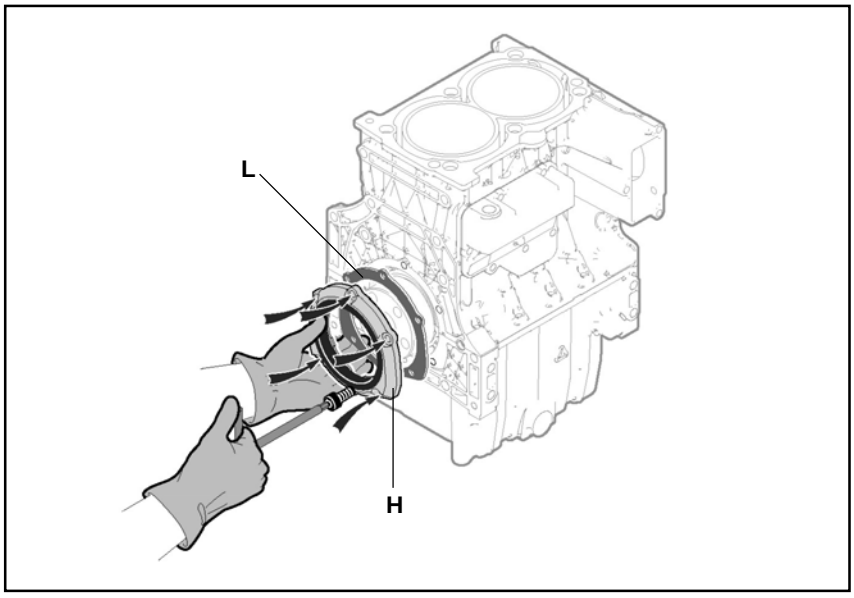
5 - Take off the gasket **(G)**.



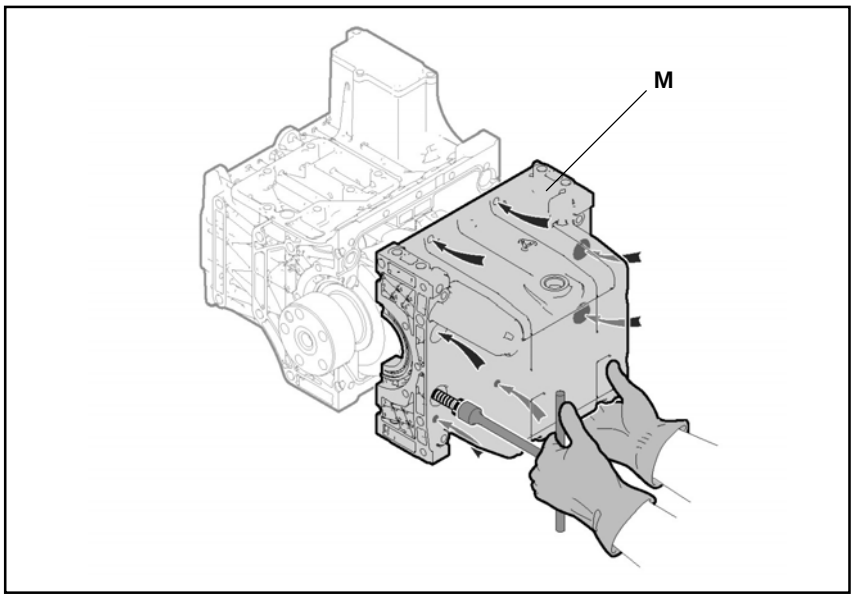
5.6.3 Disassembling the crankcase and crankshaft

1 - Remove the flange **(H)**.

2 - Tske off the gasket **(L)**.



3 - Remove the crankcase **(M)**.

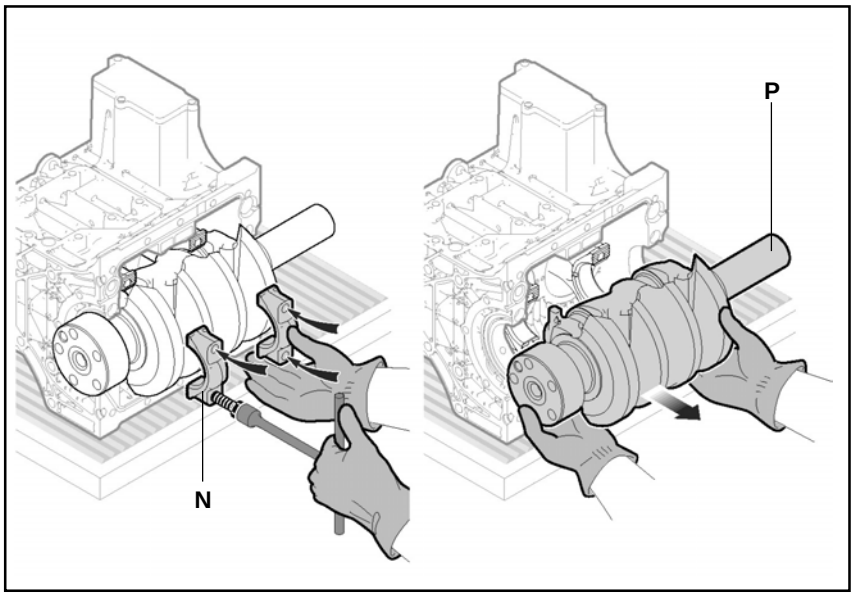


4 - Remove the connecting rod cap **(N)**.

Caution - Warning

Before removing the cap, mark the area of contact with the connecting rod, in order to recognise the right position during reassembly.

5 - Remove the crankshaft **(P)** and place it in a container for washing.



5.6.4 Disassembling connecting rod and piston

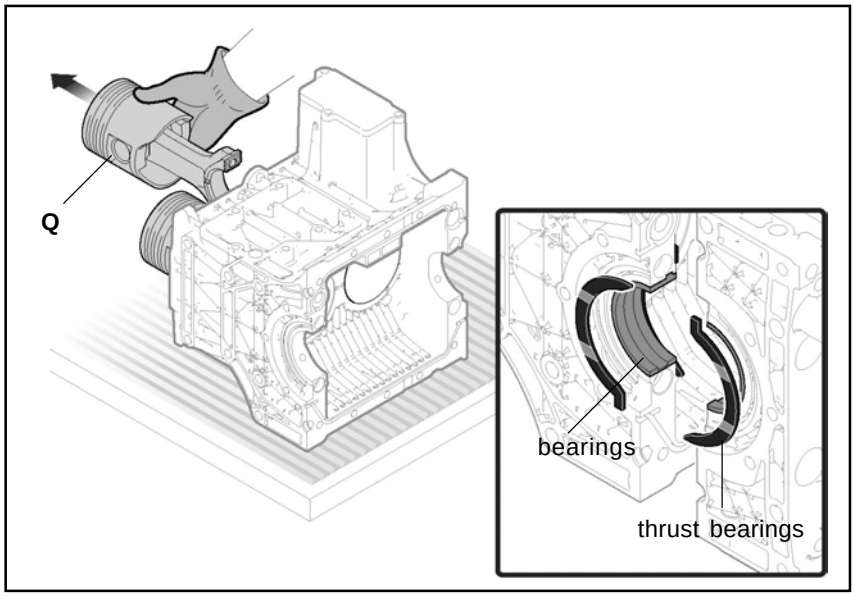
1 - Extract the connecting rod/piston assembly **(Q)**.
2 - Remove the crankshaft half bearings.

Caution - Warning

Before removing the crankshaft half bearings, mark the seat position, in order to recognise and match it up during reassembly.

Important

Be careful not to damage the half bearing during removal.

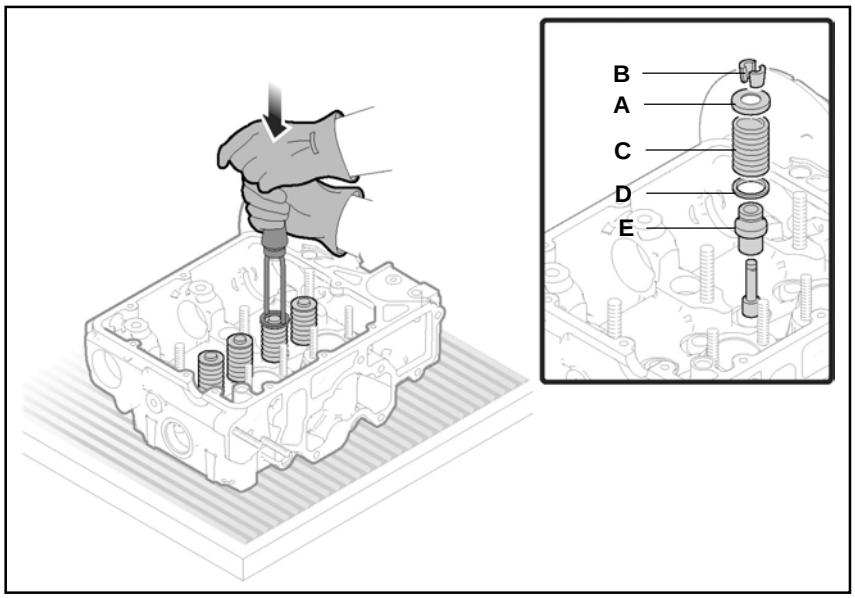


5.7 DISASSEMBLING THE VALVES

1 - Place the cylinder head on the workbench.

2 - Press down hard on the cup **(A)**, using the special tool.

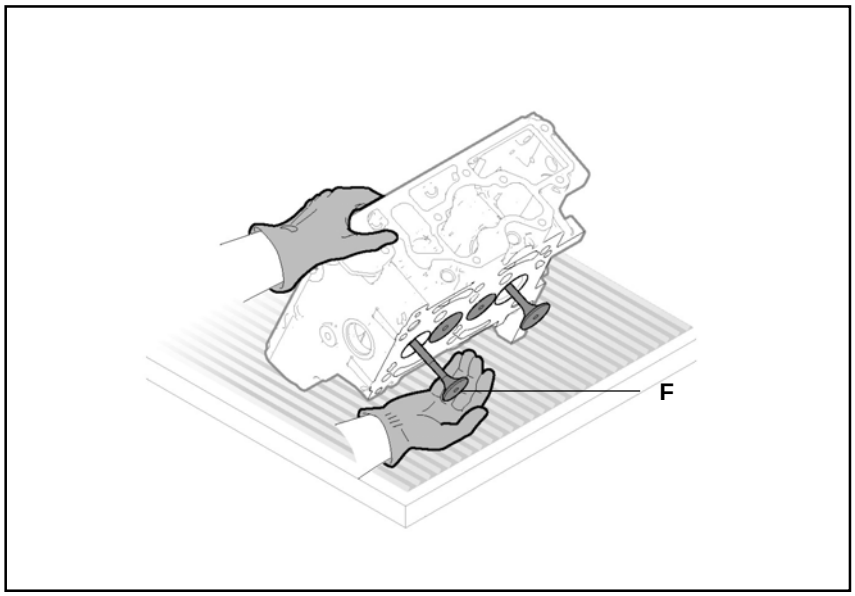
3 - Remove the half collets **(B)** blocking the cup **(A)**, the spring **(C)**, the collar **(D)** and the gasket **(E)**.



4 - Remove the valves **(F)**.

Important

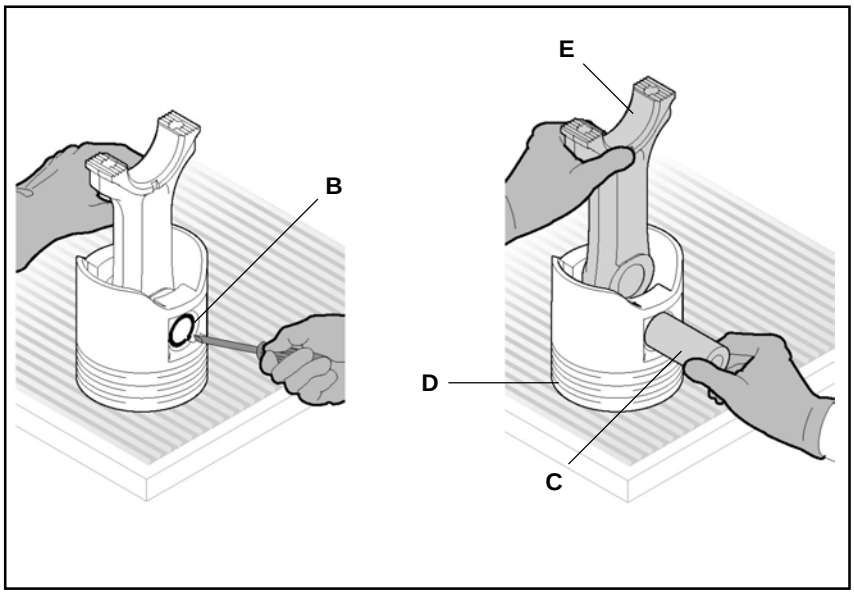
Keep components together during the disassembly phase, in order to be able to reassemble correctly.



5.8 DISASSEMBLING THE PISTON

1 - Remove the stop ring **(B**).

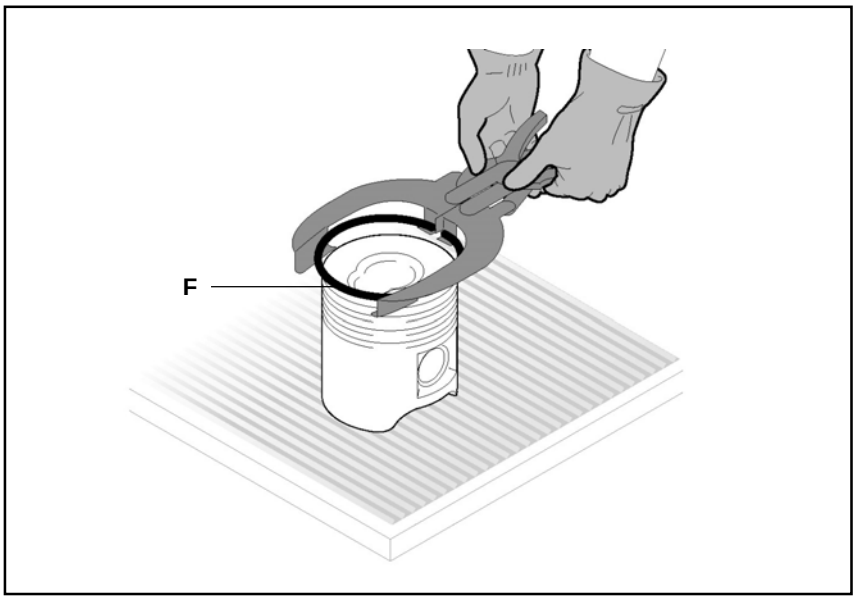
2 - Extract the wrist pin **(C)** to separate the piston **(D)** from the connecting rod **(E).**



Important

Keep each connecting rod together with its piston and wrist pin.

3 - Remove the stop rings **(F**).



Notes :

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6.1 RECOMMENDATIONS FOR OVERHAULS AND TUNING

– Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.

– This chapter describes procedures for controlling, overhauling and tuning assemblies and/or individual components.

Important

To locate specific topics, the reader should refer to the index.

– Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.

– The operator must comply with the specific measures described in order to avoid errors that might cause damage to the engine.

– Before carrying out any operation, clean the assemblies and/or components thoroughly and eliminate any deposits or residual material.

– Wash the components with special detergent and do not use steam or hot water.

– Do not use flammable products (petrol, diesel, etc.) to degrease or wash components. Use special products.

– Dry all washed surfaces and components thoroughly with a jet of air or special cloths before reassembling them.

– Apply a layer of lubricant over all surfaces to protect them against oxidation.

– Check all components for intactness, wear and tear, seizure, cracks and/or faults to be sure that the engine is in good working condition.

– Some mechanical parts must be replaced en bloc, together with their coupled parts (e.g. valve guide/valve etc.) as specified in the spare parts catalogue.

6.1.1 Shaft seals

– Clean the shaft thoroughly and make sure that it is not damaged or scored or has become oval-shaped in the areas of contact with the seals.

– Lubricate the seal lips, and pointing them in the right direction, place them in their seat using a special pad.

– Do not use a hammer directly on the gaskets during assembly, to avoid damaging them.

– Be careful not to damage the gaskets while joining them to the shaft.

6.1.2 O-Rings

– Lubricate the seal before introducing it to its seat.
– Avoid "rolling" the gasket during the attachment phase.

6.1.3 Bearings

– Use special extractors or plugs to remove bearings.

– Clean the bearings thoroughly. Check their condition and, if they are fully intact, lubricate all over, otherwise replace with original spares.

– Do not use a hammer directly on the bearings during assembly, to avoid damaging them.

6.2 OVERHAULING THE CRANK GEARS AND CRANK CASE

6.2.1 Overhauling cylinders and pistons

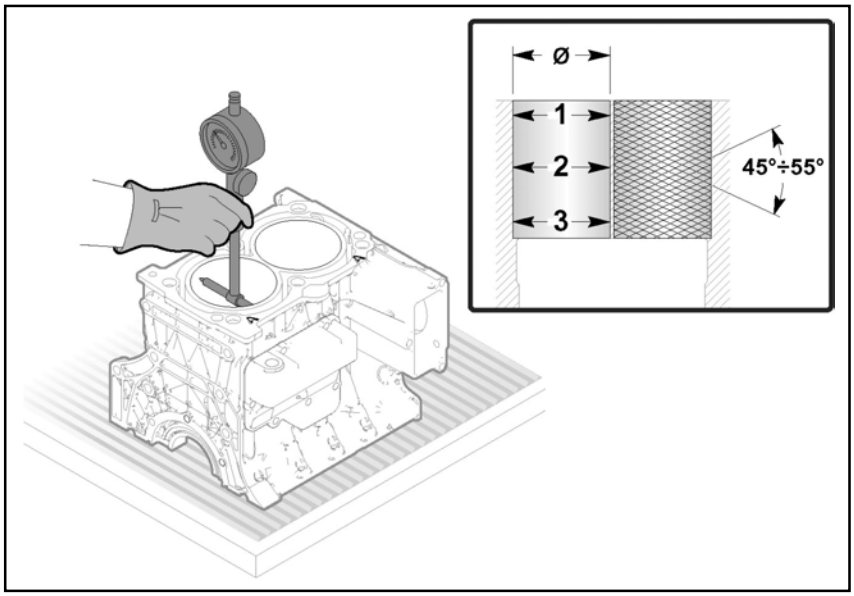
Before deciding what kind of overhaul needs to be done, it is important to carry out a dimensional check and verify the correspondence of cylinders, pistons, sealing rings, crankshaft and connecting rods.

6.2.2 Dimensional check and overhaul of cylinders

1 - Place the engine block on the workbench.

2 - Using a micrometer, measure the diameter at points **1**-**2**-**3** (see diagram).

3 - Rotate the micrometer 90° and remeasure. If ovalization or wear is greater than 0.05mm, the cylinder must be ground .



Important

- **The increases recommended by the manufacturer for the cylinder head 0.5 and 1 mm.**
- **When grinding make sure that the working angle is 45-55° and that the average roughness is Ra=0.5-1.**
- **Do not sand the internal surfaces of the cylinders using emery cloth.**
- **Protect the contact surfaces with lubricant oil, to prevent them from rusting**

The table shows the reference values and their class (only applies to new engines).

Important

Pistons with nominal diameter are supplied only in class (A) spares. Those uprated by 0.5 and 1 mm have the uprating referance (ø72.5 e ø73) engraved on the upper part of the piston (see "Table of cylinder - piston classes and dimensions").

Table of cylinder - piston classes and dimensions

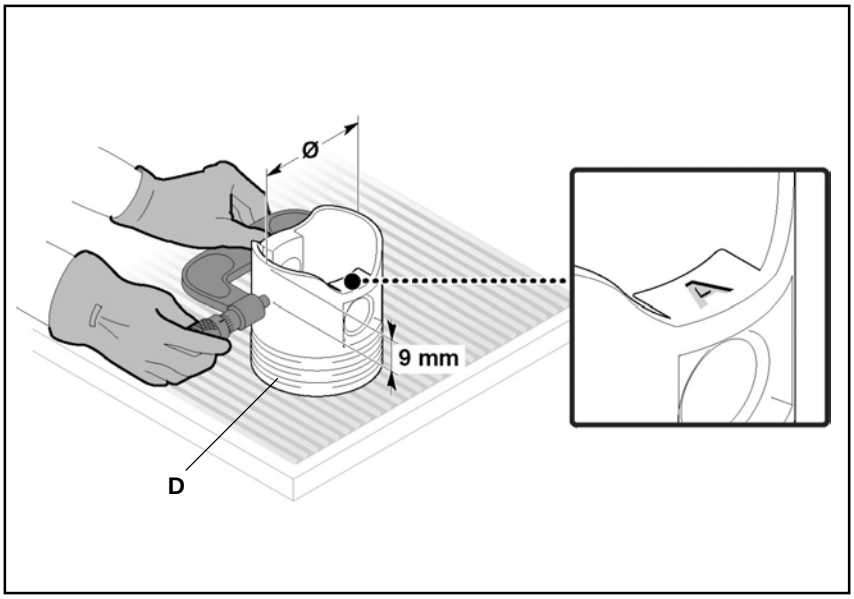
Dimension class	Ø Cylinders (mm)	Ø Pistons (mm)	clearance (mm)
A	71,990÷72,000	71,930÷71,940	0,05÷0,07
B	72,000÷71,100	71,940÷71,950	
C	72,010÷72,020	71,950÷71,960	
R	72,100÷72,120	72,031÷72,049	

6.2.3 Dimensional check and overhaul of pistons

1 - Clean the piston thoroughly **(D)**.

2 - Using a micrometer, measure the piston 9mm from the base of the skirt.

3 - Check the table to identify the class from the values detected.The class letter is engraved on the piston,
If clearance between cylinder and piston is greater than 0.05mm, the piston and sealing rings must be replaced, and rematched according to the diameter of the ground cylinders "see Table of cylinder-piston classes and dimensions").

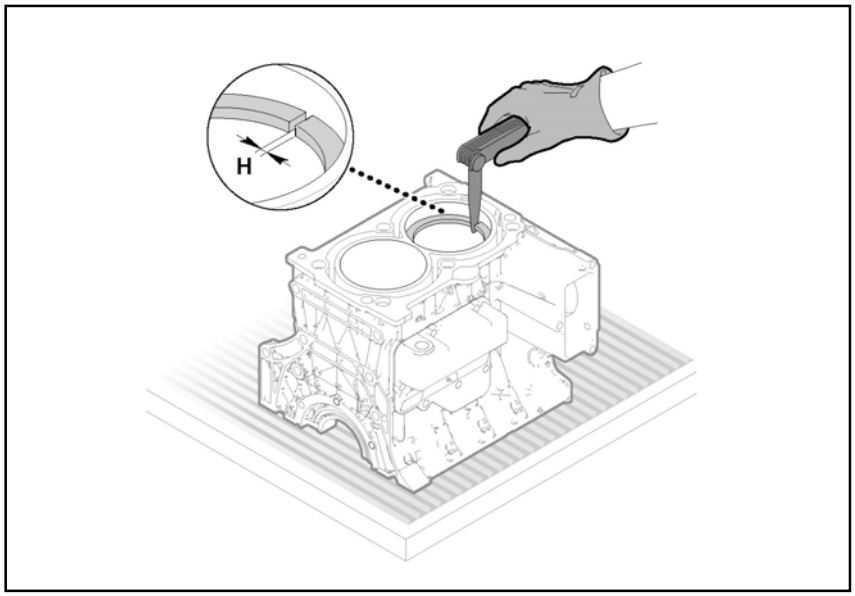


Important

Before replacing the pistons, check that the weight difference does not exceed 4g to prevent weight imbalances.

Protect the contact surfaces with lubricant oil, to prevent them from rusting.

6.2.4 Dimensional check of sealing rings

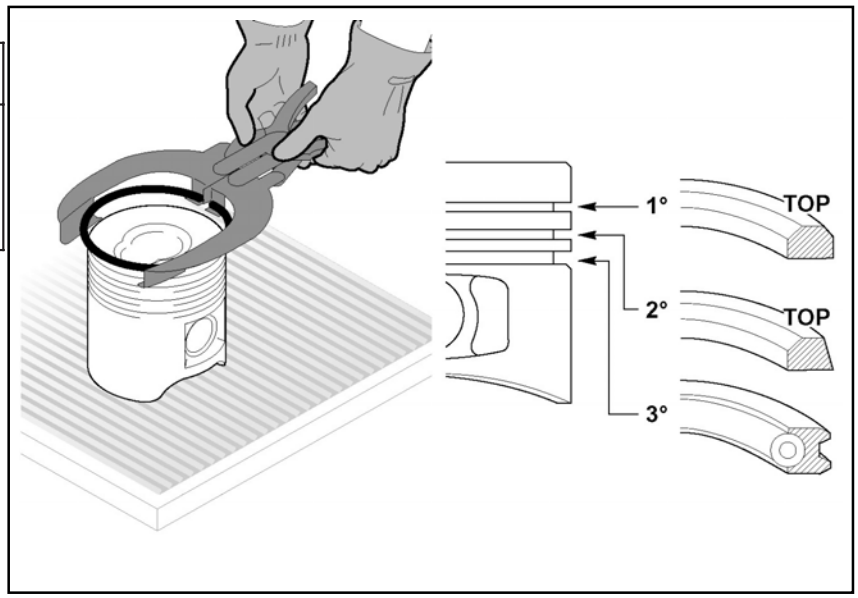


1 - Place a sealing ring in the cylinder and measure the distance between the two tips using a thickness gauge **(H)**.

2 - Repeat for all the sealing rings.
If the distance between the tips does not correspond to the indicated values, replace the sealing ring with an original spare (see "Dimensional table of sealing rings").

Dimensional table of sealing rings

Sealing rings	distance between tips (mm)	Wear & tear limit (mm)
1°	0,25÷0,45	1,0
2°	0,25÷0,45	
3°	0,20÷0,45	



3 - Put the sealing rings on the piston in the order shown in the figure.

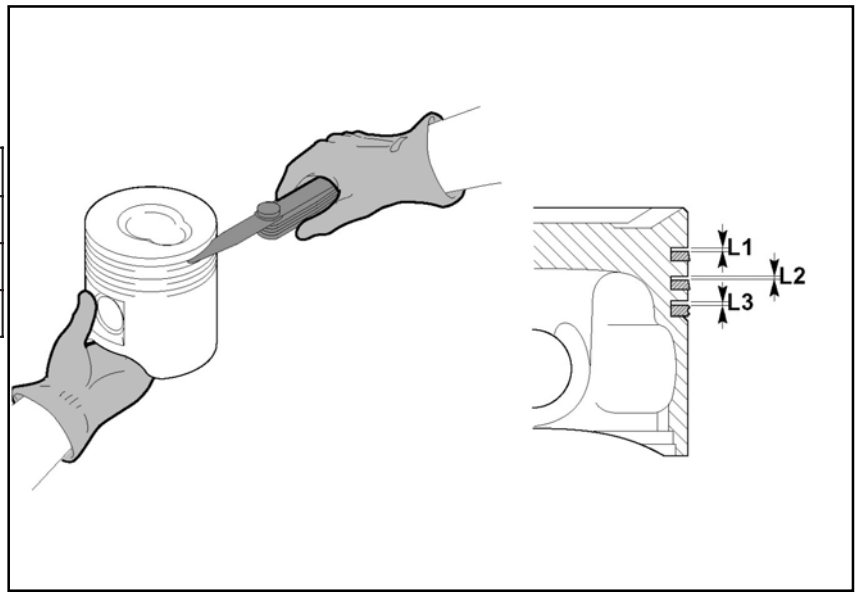
Important

Place the sealing rings with the markings facing up towards the upper part of the piston (crown).

4 - Using a thickness gauge, measure the clearance of each sealing ring. If clearance **(L)** does not correspond to the values shown, replace the sealing rings with original spares (see "Table of sealing ring clearance").

Table of sealing rings clearance

Sealing rings	Clearance (mm)
1°	L1= 0,090÷0,125
2°	L2= 0,050÷0,085
3°	L3= 0,040÷0,075



Important

- **Sealing rings cannot be replaced separately.**
- **Protect the contact surfaces with lubricant oil, to prevent them from rusting**.

6.2.5 Dimensional check and overhaul of crankshaft

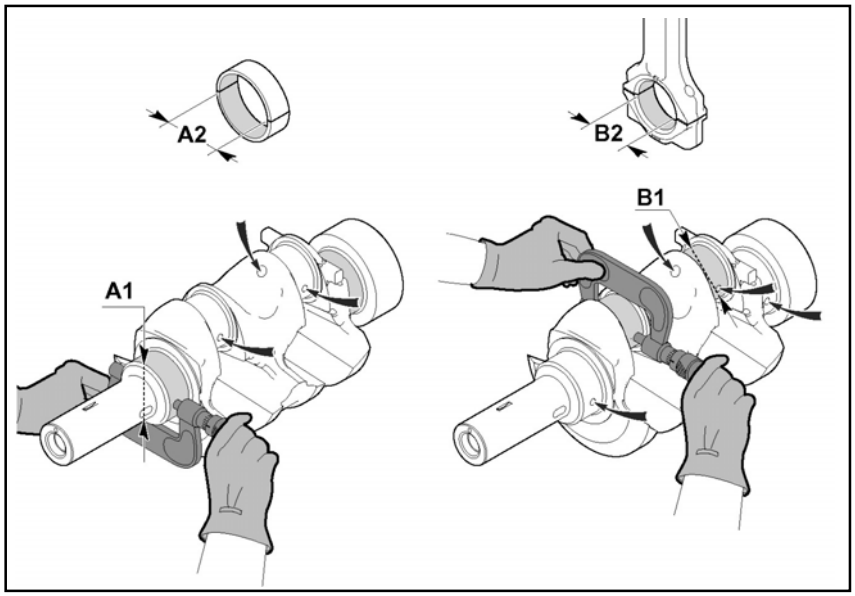
1 - Wash the crankshaft thoroughly using suitable detergent.

2 - Introduce a pipe cleaner into the lubrication ducts to remove any residual dirt.

3 - Blow compressed air into the points indicated to free the ducts from oil.

4 - Check the surfaces of the main journals and crank pins for wear and tear to see whether grinding is necessary.

5 - Using a micrometer, measure the diameter of the main journals **(A1)** and crank pins **(B1)**.



Important

- **Crankshaft half bearings cannot be replaced separately.**
- **If the crankshaft needs to be ground, establish the diameters of the connecting rod and crank pins, in order to choose the matching measurements available of connecting rod and half bearing spare parts (see "Table of diameters of connecting rods and half bearings").**
- **When grinding the crankshaft it is possible to downrate the crankshaft and connecting rod pins by 0,25 mm and 0,50 mm.**
- **When grinding the crankshaft it is also necessary to consider grinding the sides (shoulder) to be able to choose uprated ring replacements (see "Table of uprated shoulder half-rings").**

Table of diameters of connecting rods and half bearings

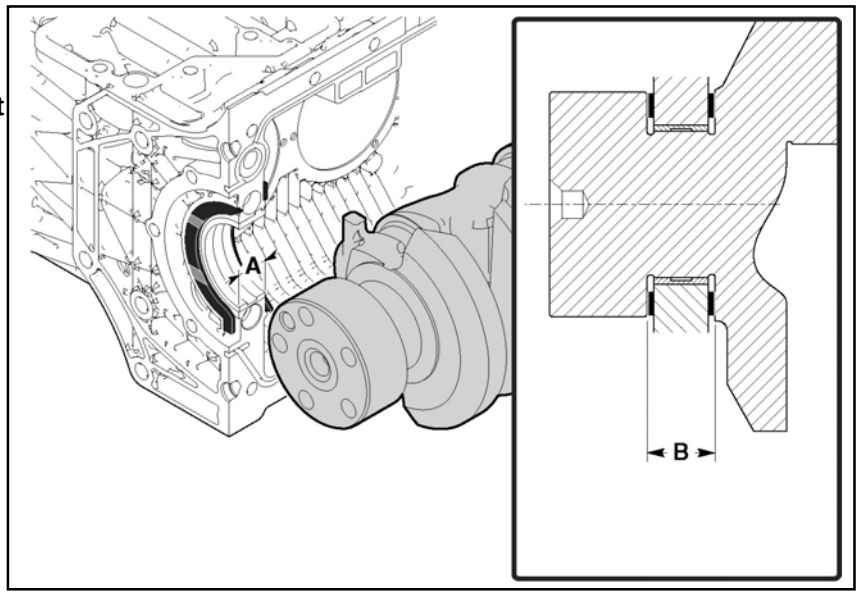
Ref.	Dimensions (mm)	Wear & tear limit (mm)	Clearance (mm)	wear & tear lim (mm)
A1	47,984÷48,000	47,900	A2-A1=0,032÷0,016	0,200
A2	48,022÷48,058	48,055		
B1	39,894÷40,000	39,900	B2-B1=0,021÷0,066	0,130
B2	40,020÷40,035	40,100		

Table of uprated shoulder half-rings

Half-rings	Dimensions (mm)		
	A	B	Clearance
Standard	22,787÷22,920	23,050÷23,100	C=A-B 0,130÷0,313
1° increase	22,987÷23,120	23,250÷23,300	
2° increase	23,087÷23,220	23,350÷23,400	
3° increase	23,187÷23,320	23,450÷23,500	

Important

Protect the contact surfaces with lubricant oil, to prevent them from rusting.

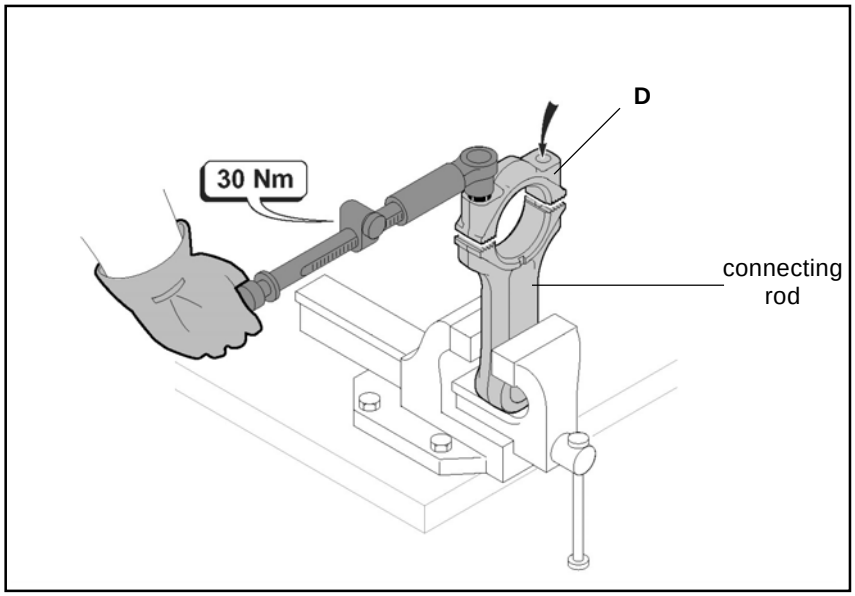


6.2.6 Dimensional check and overhaul of connecting rods

1 - Check that the contact surfaces are perfectly clean and intact.

2 - Assemble the cap **(N)** onto the connecting rod big end and tighten the screws to a torque of 38 Nm.

3 - Using a micrometer, measure diameters øa-b.



Important

- **If the diameter of the conncting rod small end does not match the diameter of the wrist pin, the connecting rods must be replaced to achieve the right match (see "Table of connecting rod dimensions").**
- **The half-bearings are supplied smaller than the nominal dimensions, by 0,25 mm and 0,50 mm.**
- **Before replacing the connecting rods, check that the weight difference does not exceed 10g to prevent weight imbalances (see "Table of connecting rod dimensions").**
- **Protect the contact surfaces with lubricant oil, to prevent them from rusting.**

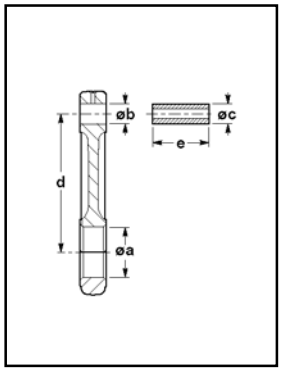


Table of connecting rod dimensions

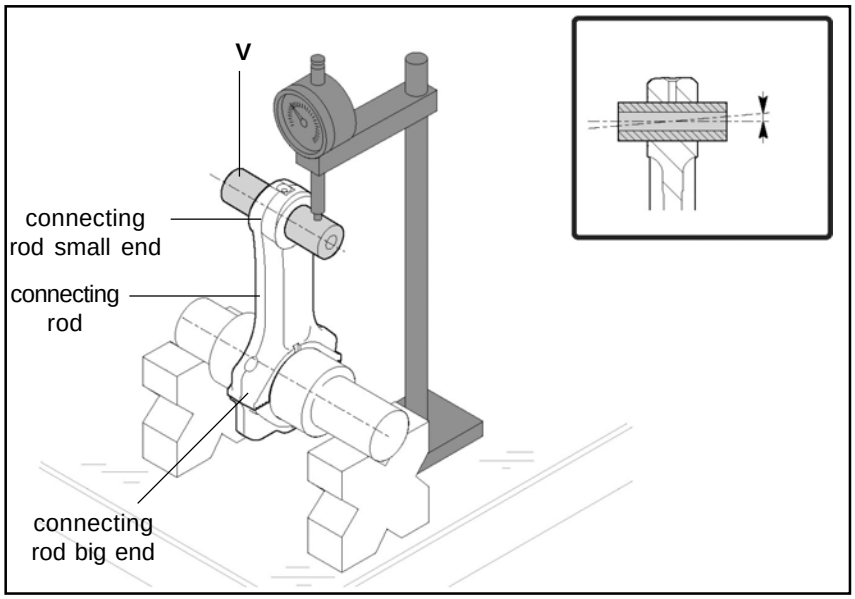
Ref.	Dimensions	Clearance (mm)	wear & tear limit (mm)
d	109,975÷110,025	Ø b-Ø c 0,010÷0,025	0,40
Ø b	20,010÷20,020		
Ø c	19,995÷20,000		
Ø a	40,020÷40,035		
e	55,000÷55,020		

6.2.7 Checking parallelism of the connecting rod axes

1 - Insert the wrist pin **(V)** in the connecting rod small end.

2 - Use a dial indicator to check that there is parallelism between the small end and big end axes. Parallel deviation, measured at the very tip of the wrist pin, must not exceed 0.015-0.030mm. If parallel values do not correspond to those indicated, replace the connecting rod with an original spare.

3 - After carrying out all checks and overhauls, remount the connecting rods, pistons and sealing rings (see "Pre-assembly of sealing rings - pistons" and "Pre-assembly of connecting rods - pistons").

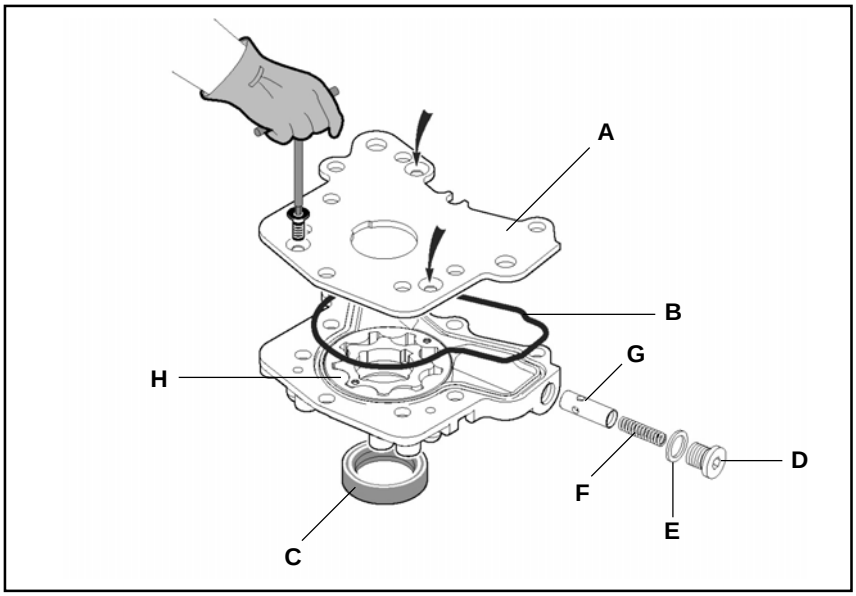


Important

Protect the contact surfaces with lubricant oil, to prevent them from rusting.

6.2.8 Check and overhaul of the fuel pump

Disassemble the oil pump before checking or overhauling. See “Disassembling the oil pump” for the correct procedure.



1 - Remove the plate **(A)**.

2 - Remove the O-ring **(B)**.

3 - Remove the sealing ring **(C)** from the flange and clean the seat.

4 - Unscrew the oil **(D)** and extract the gasket **(E)**, the spring **(F)** and the valve **(G)**.

5 - Disassemble the rotors **(H)**.

6 - Blow compressed air into the valve seat to clean it.

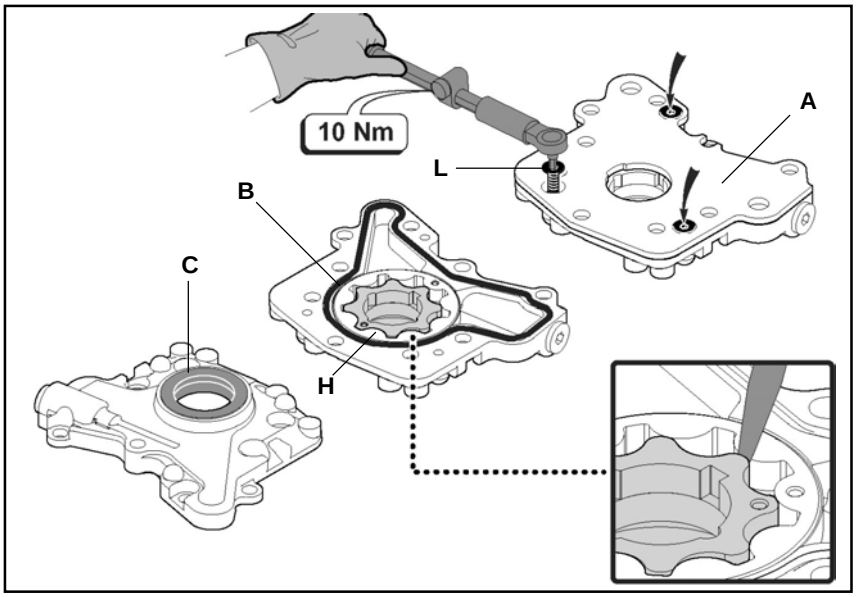
7 - Thoroughly clean all the components.

8 - Measure the length of the spring **(F)**.
If the length of the spring is not between 27.50 and 27.75mm, replace it with an original spare.

9 - Replace the valve **(G)**, the spring **(F)**, the gasket **(E)** and the plug **(D)**.

10 - Fill the sealing ring **(C)** with grease and lubricate the rim with oil.

11 - Mount the new sealing ring **(C)** using a special tool.



Important

Given the particular function played by this sealing ring, it is important to use only original spares.

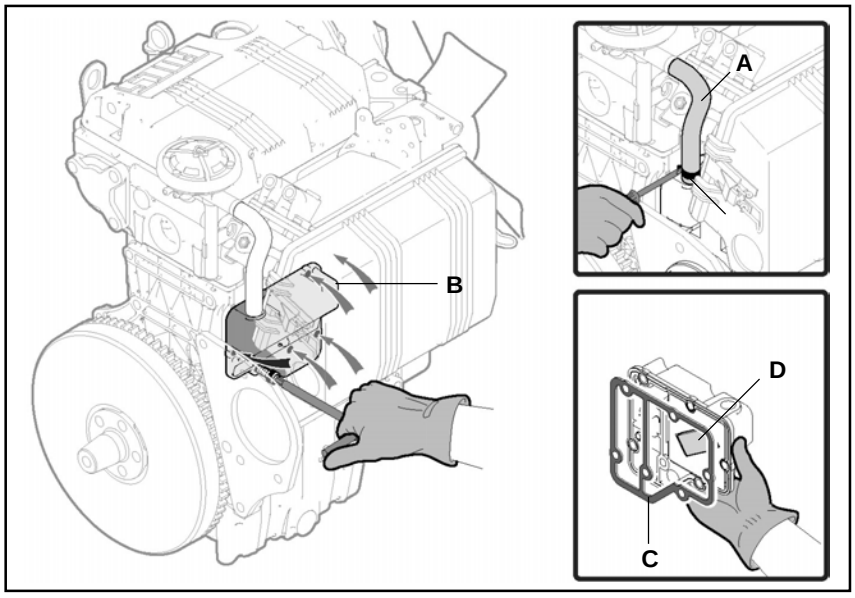
12 - Mount the rotors **(H)** with the referance notches facing upwards so that they are visible.
13 - Using a thickness gauge, measure the clearance between the rotor teeth.
If clearance is above the 0.25mm limit for wear, replace the rotors with original spares.
14 - Check that the contact surfaces are perfectly clean, intact and not deformed.
15 - Mount the new O-ring.

Important

The O-ring must always be replaced with an original spare part whenever the pump is disassembled.

16 - Replace the plate **(A)** and put in the screws **(L)**.
17 - Tighten the screws **(L)** to a torque of 10 Nm.

6.2.9 Overhauling the decanting device



In order to overhaul the decanting device, it is necessary to disassemble the starter motor. See “Replacing the starter motor” for the correct procedure.

1 - Loosen the clamp and extract the pipe **(A**).

2 - Remove the cover **(B**).

3 - Thoroughly clean the inside of the cover and blow compressed air on the decanting device **(C)** to eliminate residues.

4 - Check that the decanting device is intact and, if necessary, replace it with an original spare.

5 - Slip ona new gasket **(D**).

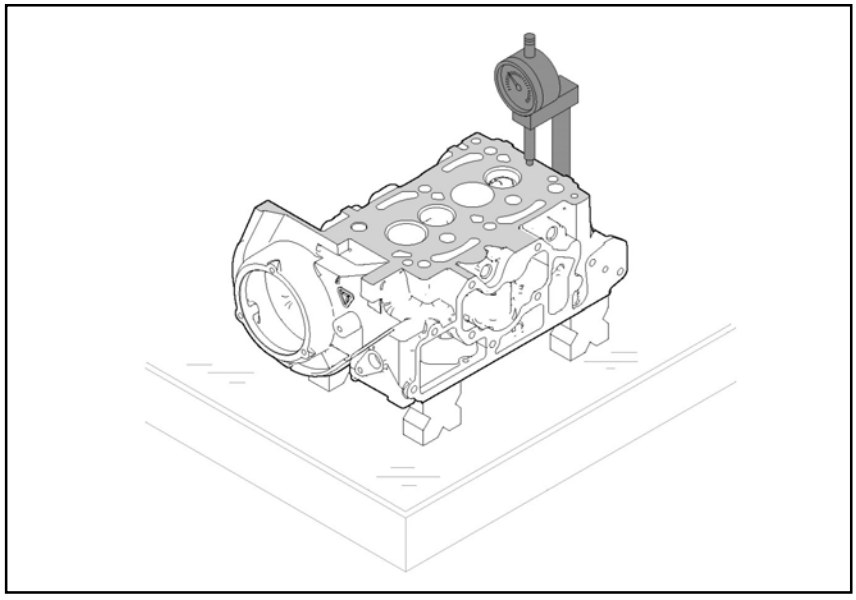
6 - Replace the cover **(B)** and fix it using the screws.

7 - Replace the pipe **(A)** and fasten it using the clamp.

8 - Mount the starter motor and tighten the screws to a torque 45 Nm.

6.3 OVERHAUL OF CYLINDER HEAD AND RELATED COMPONENTS

6.3.1 Checking and overhauling the cylinder head



1 - Place the cylinder head on a surface plate and position it with the corners on the stud bolts.

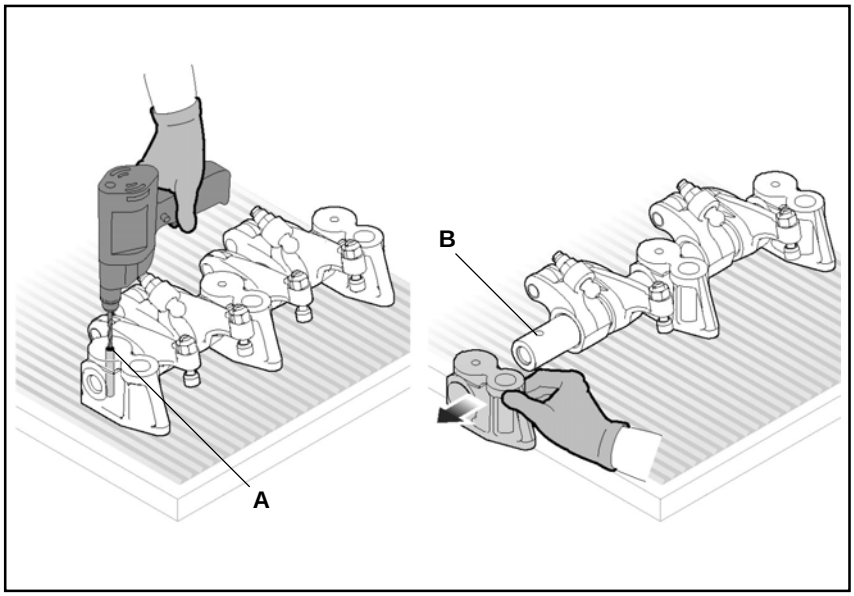
2 - Using a dial indicator make sure the cylinder head is level.

Important

If the level deviation is above 0.1mm, the cylinder head must be ground, removing not more than 0.2mm.

3 - Before grinding, remove the valves (see “Disassembling the valves”) and the precombustion chambers (see “Disassembling the precombustion chamber”).

6.3.2 Checking and overhauling the rocker arm pin

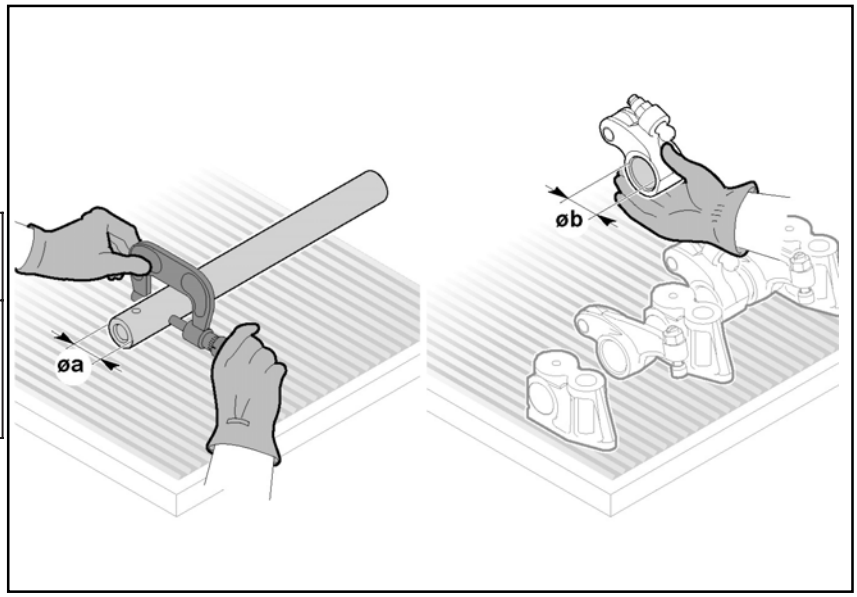


1 - In order to carry out a control of the rocker arm assembly, it is necessary to disassemble the cylinder head.
See “Disassembling the rocker arms” for the correct procedure.

2 - Bore a hole in the blocking pin **(A)**, using a 4mm bit to remove it.

3 - Extract the supports and the rocker arm from the pivot pin **(B)**.

4 - Thoroughly clean the components.

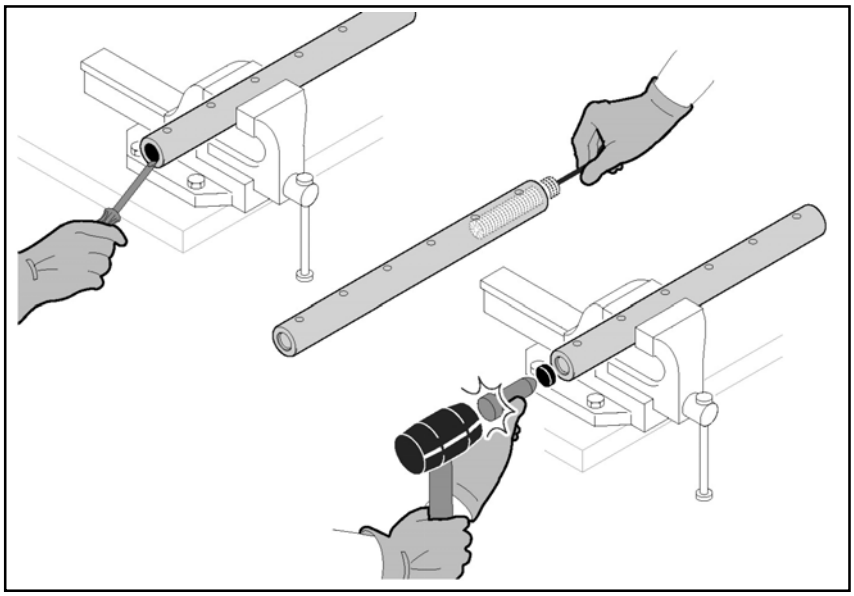


5 - Using a micrometer measure, the diameters of the pivot pin and the rocker arms (see “Table of dimensions pin-rocker arm”).

Table of dimensions pin-rocker arm

Ref.	Dimensions	Clearance (mm)	Tear & wear limit (mm)
Ø a	17,989÷18,000	Ø a -Ø b= 0,015÷0,041	0,090
Ø b	18,015÷18,030		

If the diameters do not correspond to the values shown, replace the pin and, if necessary, the rocker arms with original spares.
If the pin can be re-used, remove the plugs and clean the inside carefully, to eliminate residual dirt.

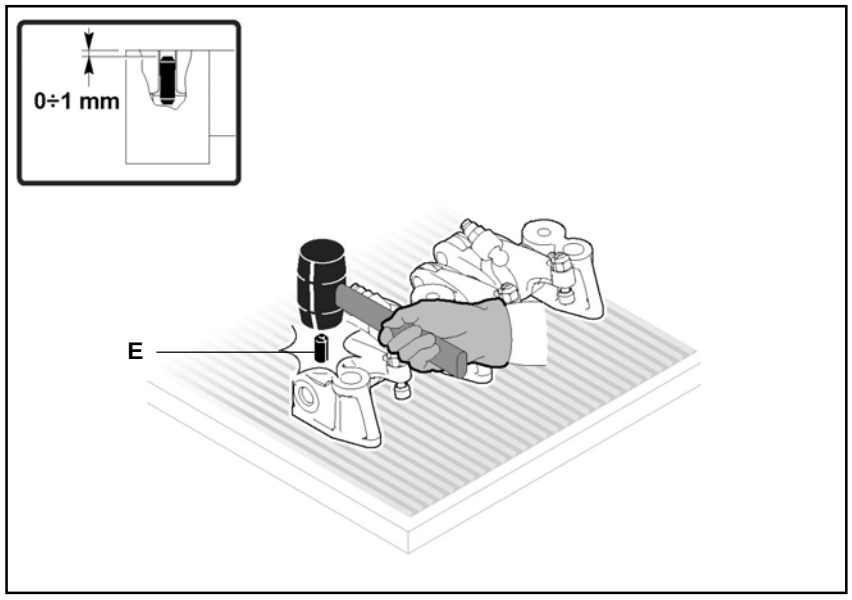


6 - Place the new plugs in the pin.

7 - Carefully clean and lubricate the supports and rocker arms and remount on the pin.

8 - Insert a new pin **(E)** and drive it in 0÷1 mm from the flat part of the support.

9 - Reassemble the rocker arm assembly in the cylinder head (see “Assembling the rocker arms”).



6.3.3 Checking and replacing the camshaft

In order to carry out a control of the camshaft, it is necessary to disassemble it from the cylinder head.
See “Disassembling the camshaft” for the correct procedure.

1 - Using a dial indicator, measure the diameters of the seats **(X)** and, with a micrometer, find out the diameters of the camshaft (øa-b) (see “Table of camshaft dimensions”).

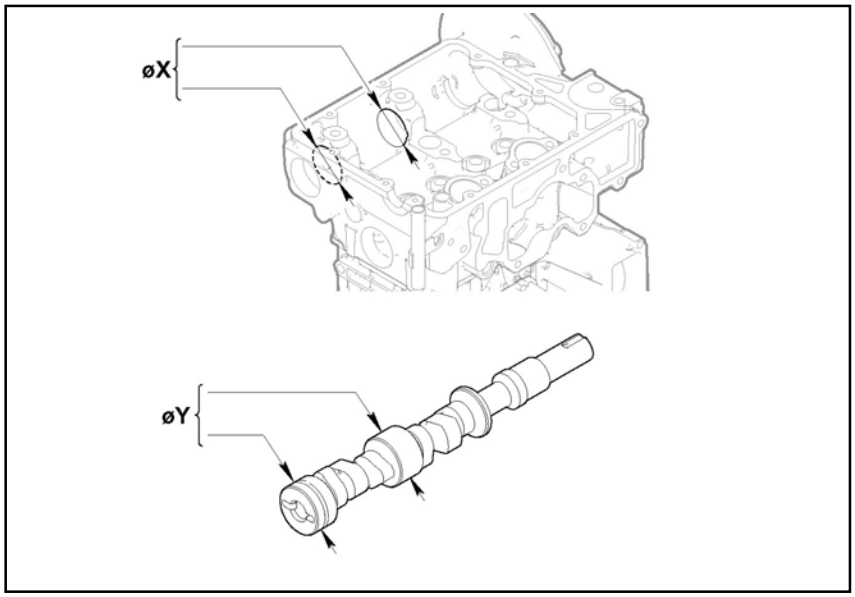


Table of camshaft dimensions

Ref.	Dimensions	Clearance (mm)	Tear & wear limit (mm)
Ø a	37,035÷37,060	Ø a-Ø b= 0,035÷0,085	0.170
Ø b	36,975÷37,000		

If the diameters do not correspond to the values shown, replace the camshaft with an original spare.

2 - Use a micrometer to measure the maximum dimensions of the involutes of the intake, exhaust and injection cams (see "Table of cam dimensions").

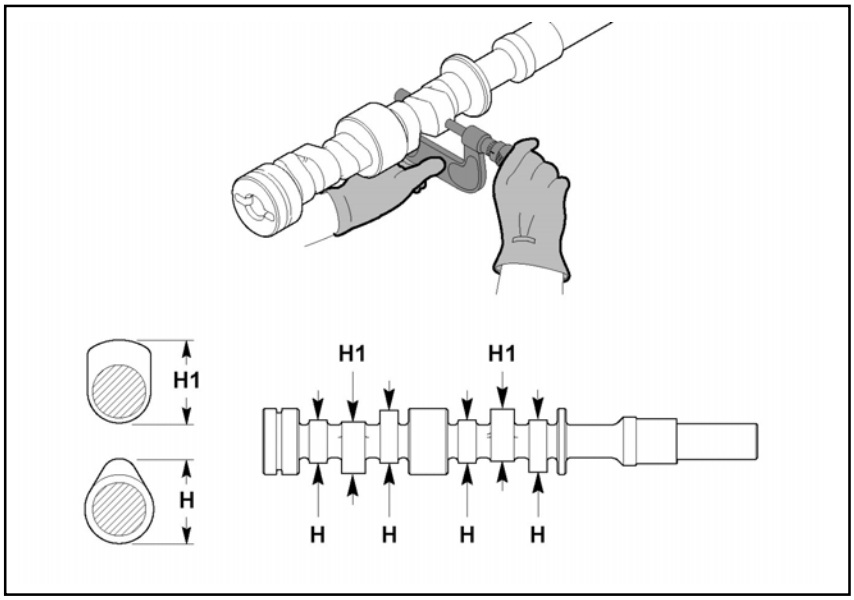


Table of cam dimensions

Ref.	Dimensions (mm)
H	29,598÷29,650
H1	28,948÷29,000

If the dimensions of cam involutes are lower than the values shown by 0.1mm (maximum dimension), replace the camshaft with an original spare.

Important

Protect the contact surfaces with lubricant oil, to prevent them from rusting.

3 - Replace the camshaft (see "Assembling tha camshaft").

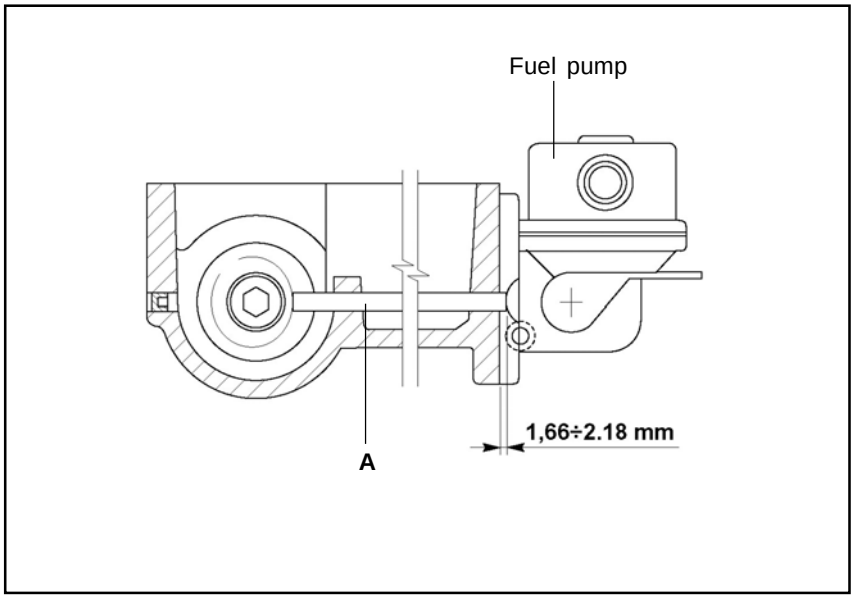
6.3.4 Checking and replacing the fuel pump drive rod

To check the drive rod it is necessary to disassemble the fuel pump.
See "Disassembling the fuel pump" for the correct procedure.

1 - Rotate the camshaft until the drive rod is at the most indented point.

2 - Check that the distance between the drive rod **(A)** and the cylinder head is between 1.66 and 2.18mm. If the distance does not correspond to this value, replace the drive rod with an original spare.

3 - Assemble the fuel pump (see "Assembling the fuel pump").



6.3.5 Checking and overhaulimg the valves

In order to carry out a control of the valves, it is necessary to remove them from the cylinder head. See “Disassembling the valves” for the correct procedure.

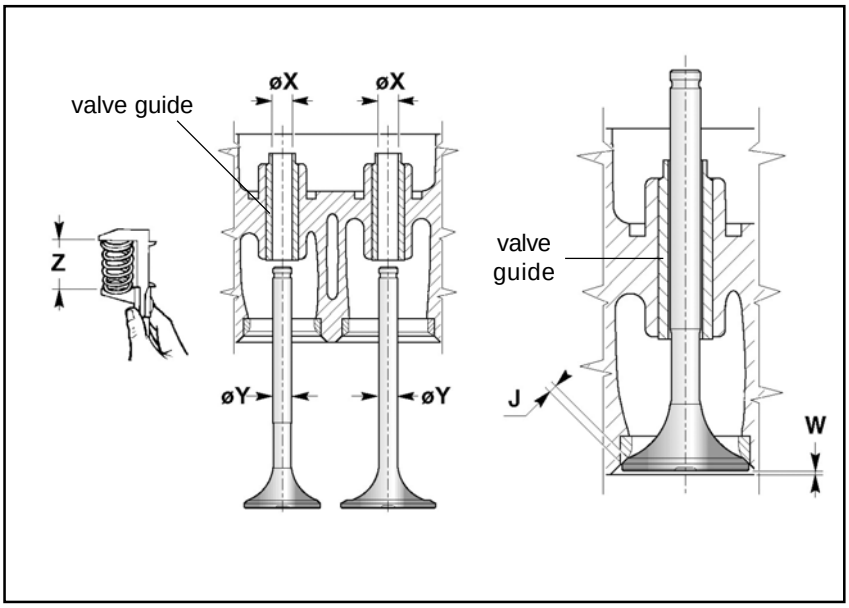
1 - Use a gauge to measure the length of the springs (see “Table of dimensions for springs – valve stems – valve guides”).

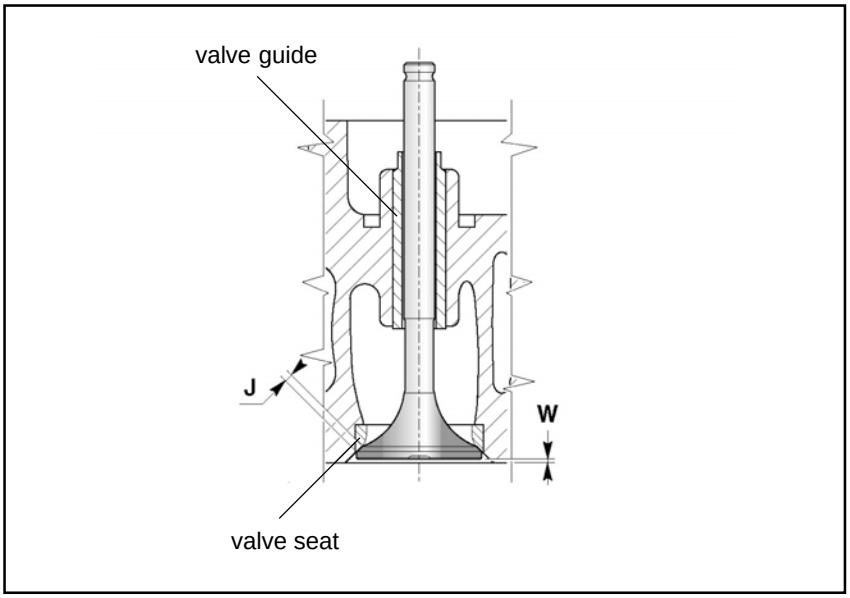
Table of dimensions for springs - valve stems - valve guides

Ref.	Dimensions (mm)	Clearance (mm)	Wear & tear limit (mm)
Ø x	7,005÷7,020	Ø b-Ø c 0,05÷0,005	0,10
Ø y	6,960÷6,990		
Z	43,5÷46,0		
W	0,5÷0,8		1,1
J	1,6÷1,7		2,0

If the length does not correspond to the value shown, replace the springs with original spares.

2 - Use a micrometer to measure the diameters of the valve stems and guides (see “Table of dimensions for springs – valve stems – valve guides”). If the diameters do not correspond to the values show, replace the valves and guides with original spares.





Important

Take measurements in several places in order to discover possible ovalization and/ or wear.

3 - Thoroughly clean the valves and their seats.

4 - Measure the width of the seal for each valve **(J)** and the indentation **(W)** from the flat part of the cylinder head (see “Table of dimensions for springs – valve stems – valve guides”). If the dimensions do not correspond to the values shown, replace the valve seat ring with an original spare.

5 - Use a pointed tool to take out the valve seats.

6 - Remove any debris, clean the valve seat holder carefully and scrape the mouth.

7 - Lubricate the new valve seats and put them into the holder manually.

8 - Use the special tool to put the valve seats in the holder.

9 - Slide the valves into their seats.

10 - Measure the degree of indentation of each valve from the flat part of the cylinder head (see “Table of dimensions for springs – valve stems – valve guides”). Se le dimensioni rilevate corrispondono ai valori indicati, smerigliare ogni valvola nella propria sede.

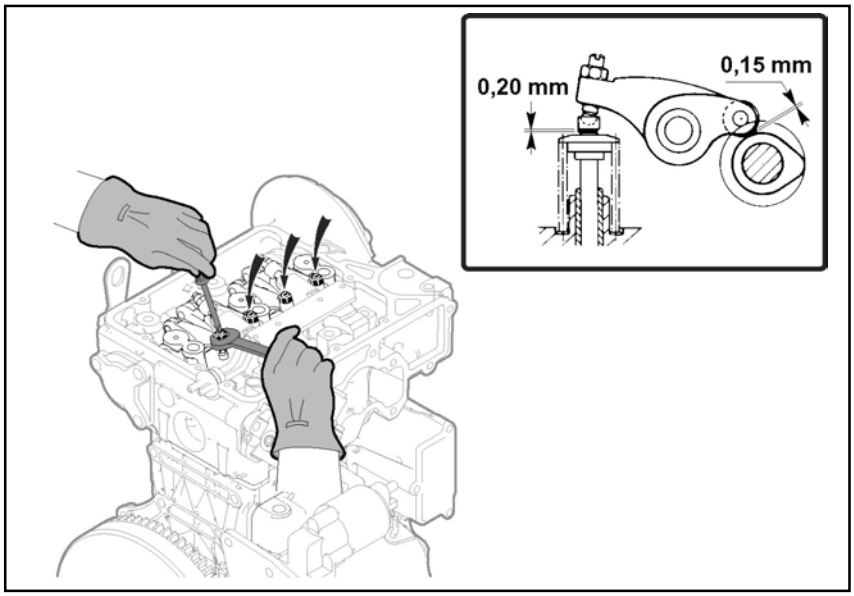
Important

Protect the contact surfaces with lubricant oil, to prevent them from rusting.

11 - Assemble the valves (see “Assembling the flywheel”).

6.3.6 Adjusting valve-rocker arm clearance

In order to make the adjustment, it is necessary to remove the rocker arm cover.
See “Disassembling the rocker arm cover” for the correct procedure.



Important

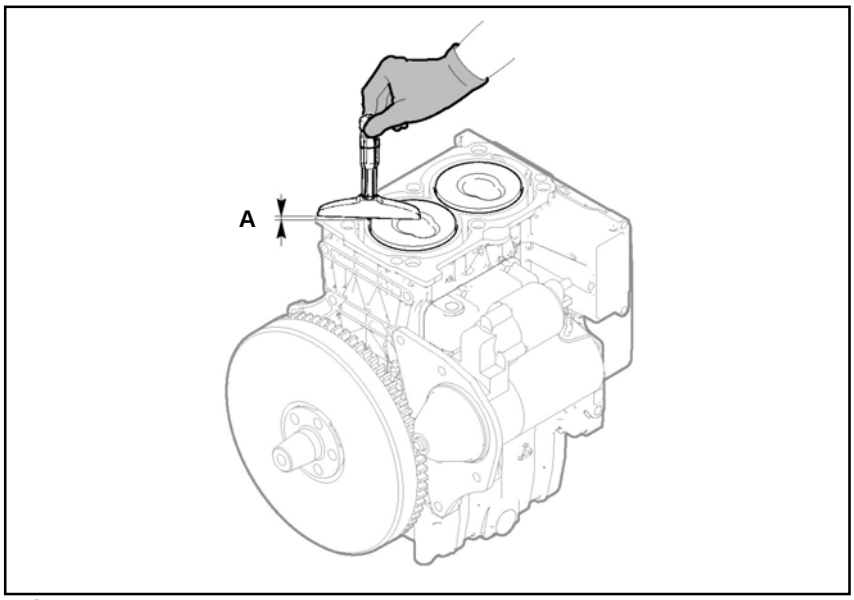
Adjustment of valve clearance must be done when the engine is cold.

1 - Place the pistons at the compression top dead centre.

2 - Turn the screw and the lock nut to adjust clearance. Adjustment can be made in two different points: the contact area between the rocker arm and the camshaft (0.15mm) and/or the contact area between the rocker arm and the valve (0.2mm).

3 - Repeat the same operation on the other valves.

6.3.7 Checking clearance volume



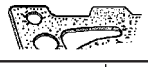
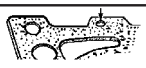
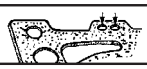
1 - Position the pistons at the top dead centre.

2 - Measure the distance in four diametrically opposite points on the piston crown.

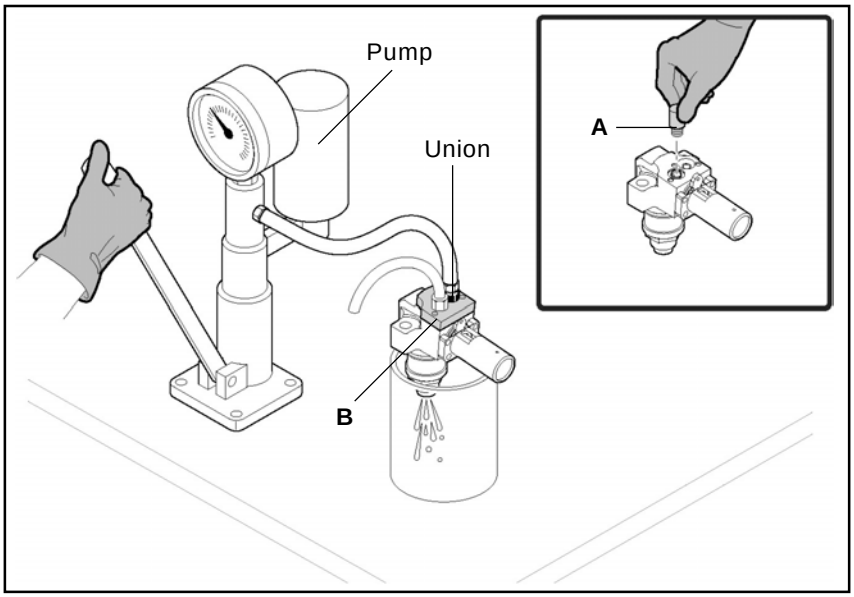
3 - Repeat the operation on all pistons.
The maximum value determines the measurement **(A)**.

Choose the gasket corresponding to the measured value. This match determines the value of the clearance volume (see “Table of head gasket and clearance volume values”).

Table of head gasket and clearance volume values

A (mm)	Number of holes		Clearance volume (mm)
0,97÷1,06	0		0,39÷0,48
1,07÷1,16	1		
1,17÷1,25	2		0,40÷0,48

6.3.8 Calibrating the injector



To carry out setting, the injector pump must be disassembled from the engine.
Per conoscere la procedura corretta, vedi “Smontaggio pompe-iniettori”.

1 - Remove the non-return valve **(A)** and replace it with the plug supplied with the “7107-1460-074” tool.
2 - Mount the tool head **(B)** and fasten with the screws.
3 - Connect the pump for calibrating the diesel injectors to the head union.
4 - Press the pump and bring to a pressure of 130 bars for 10 sec, in order to check the needle seal. Replace the nozzle (see “Nozzle-injector replacement”) if there is any dripping.
5 - Press the pump again and check to see whether the fuel comes out at a pressure of 140-155 bars (optimal operating calibration).
6 - If calibration is not optimal, it is possible to modify the action of spring, using the adjustment shims. The adjustment shims are available in 11 sizes between 1mm and 2mm, uprated at 0.1mm gaps.
If after inserting the largest adjustment shim (2mm) optimal calibration is still not achieved, the spring (see “Nozzle-injector replacement”) must be replaced.
7 - After replacing the spring, calibrate at 10 bars higher than the optimal operating calibration of 140-155 bars. When the spring settles, the calibration will level at the optimal value.
8 - Remove the tool “7107-1460-074”.
9 - Replace the non-return valve.
10 - Assemble the injection-pump on the engine (see “Assemble injection –pumps”).

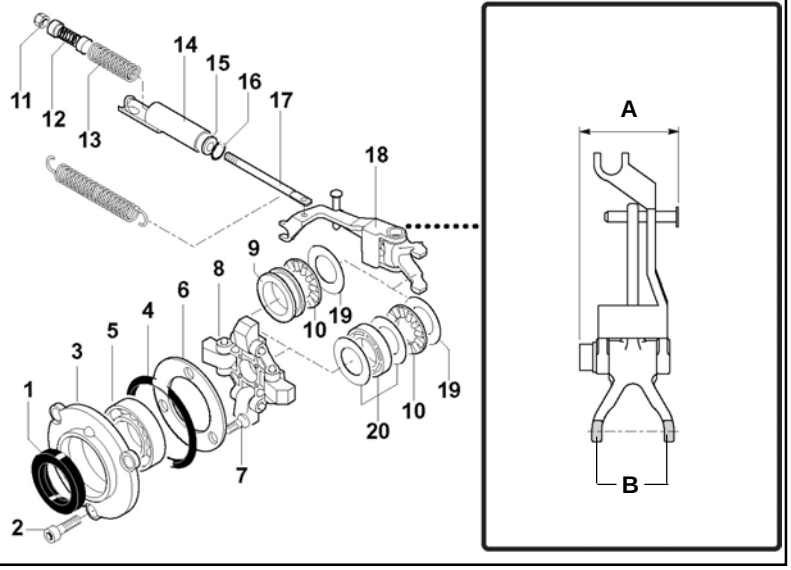
6.3.9 Checking and overhauling the speed governor

Disassemble the speed governor before checking or overhauling.
See “Disassembling the speed governor and flow limiter” for the correct procedure.

1 - Verificare, con un calibro, Use a gauge to make sure that the distance **(A)** is between 45 and 46 mm.
2 - Make sure that the contact surfaces are perfectly level with a deviation of no more than 0.05 mm.
If the deviation is greater than this, replace the speed governor with an original spare.

Exploded diagram of the speed governor

Caption
1) Oil seal
2) Screw
3) Cover
4) O-ring
5) Ball bearing
6) Plate
7) Screw
8) Weighted support
9) Spacing collar
10) Fith wheel coupling
11) Nut
12) Idle spring
13) Maximum speed ring
14) Barrel
15) Thrust washer
16) Stop ring
17) Pivot
18) Leverage assembly
19) Clearance ring
20) Hose (in some versions)



6.4 CHECKING TIMING BELT RATING

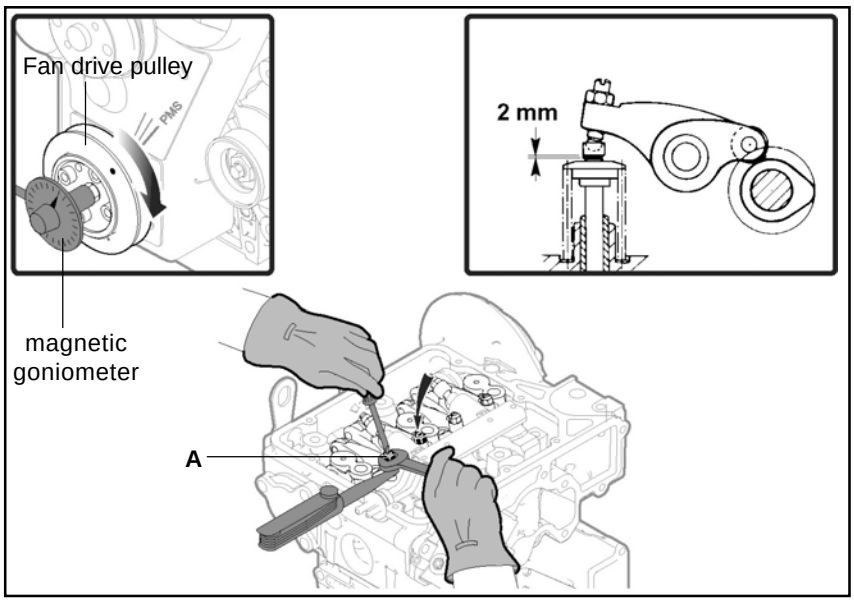
6.4.1 Valve adjustments

1 - Bring the piston to the compression top dead centre.

2 - Adjust the screw (**A**) and the lock nut in order to adjust the rocker arm valve clearance to 2 mm.

3 - Rotate the crankshaft clockwise through 360° in order to make the piston reaching the balancing top dead centre.

4 - Apply a magnetic goniometer on the crankshaft pulley and set it to zero.



5 - Place two dial indicators on the collars of the intake and exhaust valves, then set them to zero.

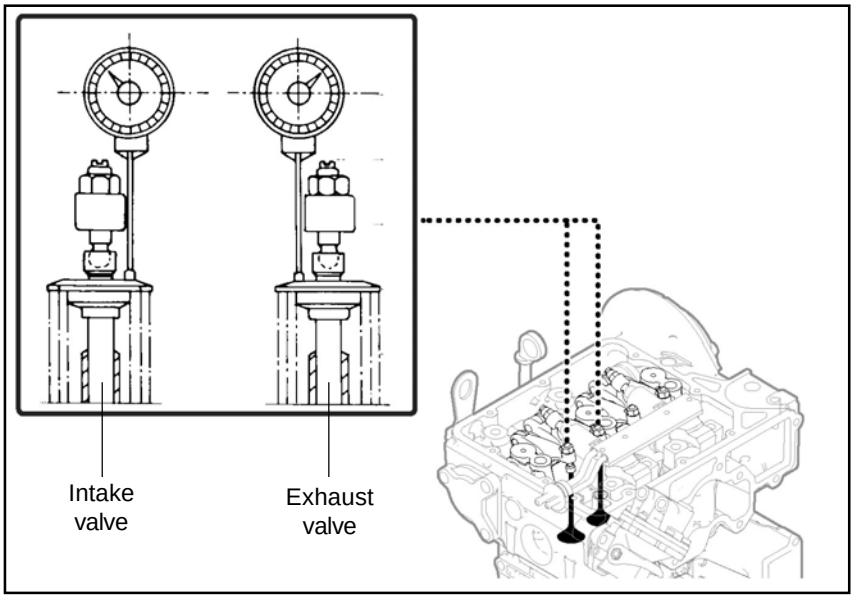
6 - Rotate the crankshaft clockwise until the dial indicator moves away from zero.

7 - Measure the rotation angle of the crankshaft by using the magnetic goniometer.
The value registered indicates when the intake valve starts opening.

8 - Go on rotating the crankshaft clockwise until the dial indicator stops at point “0”.

9 - Measure the rotation angle of the crankshaft by using the magnetic goniometer.
The value registered indicates when the intake valve starts closing.
The values registered must coincide with those indicated on the timing angle diagrams (see “Distribution timing angle diagram”).

10 - Repeat these procedures on the other valves.

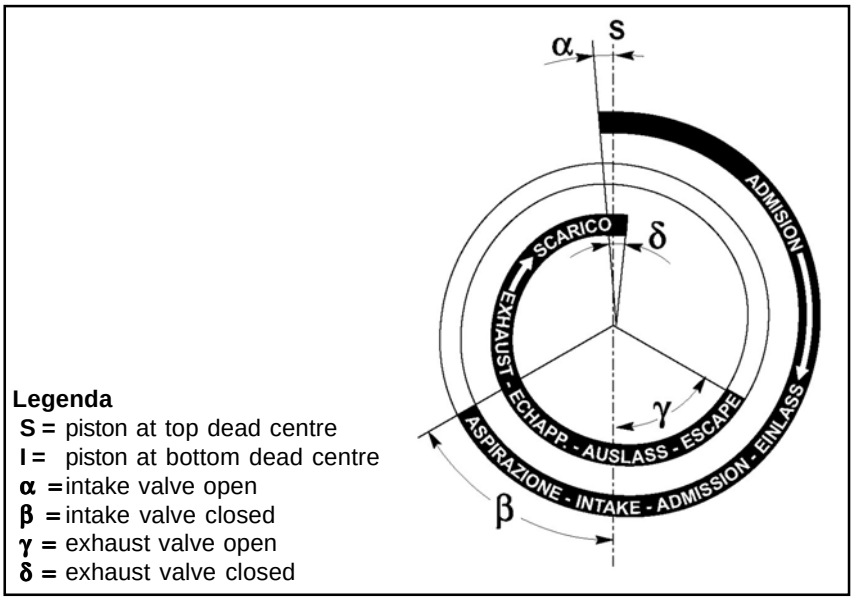


6.5 DIAGRAM OF TIMING BELT RATES

Rotate the crankshaft clockwise to find out the timing rates of the entire cycle in each cylinder (operation and control).

Timing belt operating angles (valve clearance 0.25 mm)
α = 14° before **S** (top ded centre)
β = 38° after **I** (bottom dead centre)
γ = 34° before **I** (bottom dead centre)
δ = 18° after **S** (top ded centre)

Timing belt control angles (valve clearance 2 mm)
α = 25° after **S** (top ded centre)
β = closes **2°** dopo **I** (bottom dead centre)
γ = 5° after **I** (bottom dead centre)
δ = 18° before **S** (top ded centre)



Legenda
S = piston at top dead centre
I = piston at bottom dead centre
α = intake valve open
β = intake valve closed
γ = exhaust valve open
δ = exhaust valve closed

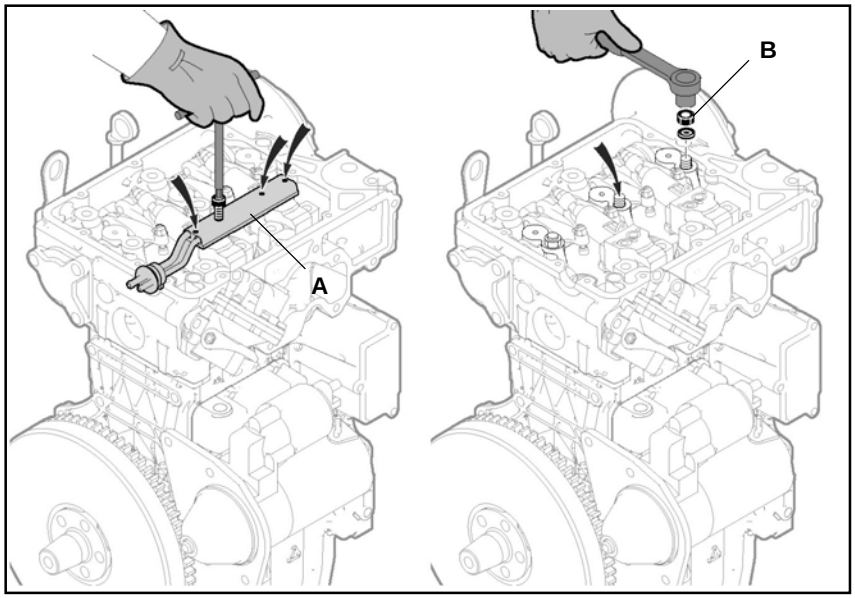
6.6 ADJUSTING STATIC INJECTION TIMING

In order to adjust injection timing, it is necessary to remove the rocker arm cover.
See “Disassembling rocker arm cover” for the correct procedure.

1 - Disassemble the injector pump fuel rail **(A)**.

2 - Select the cylinder on which the injection static advance adjustment will be carried out.

3 - Unscrew the rocker arm support nut (**B**) corresponding to the cylinder on which the procedure will be carried out.



4 - Assemble the dial indicator on stud bolt **(C**).

5 - Place the dial indicator tracer on the exhaust valve collar.

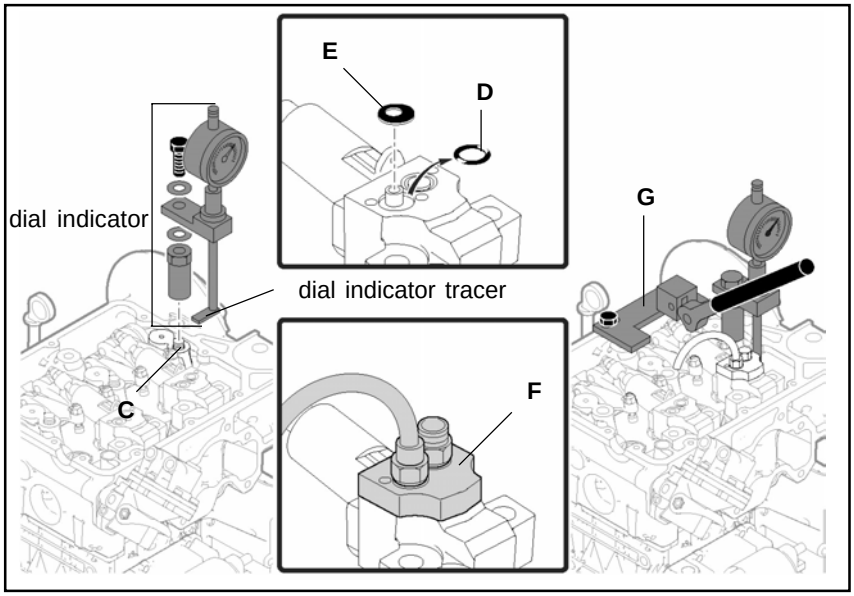
6 - Remove the O-ring **(D)** from the little non-return valve and replace it with the suitable rubber cap **(E)** (part of tool "7107-1460-048").

7 - Install the tool metal base plate **(F)**.

8 - Remove the rocker arm cover gasket.

9 - Fix the tool lever base **(G)** on cylinder head.

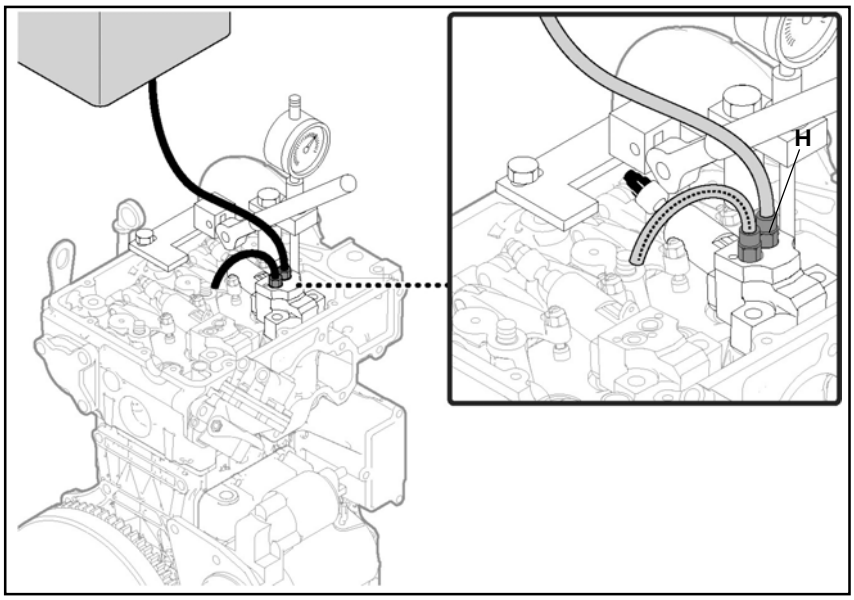
10 - Rotate the crankshaft clockwise until the injection cam acts on the rocker arm that controls the injector pump.



In these conditions, the piston is near the compression top dead centre.

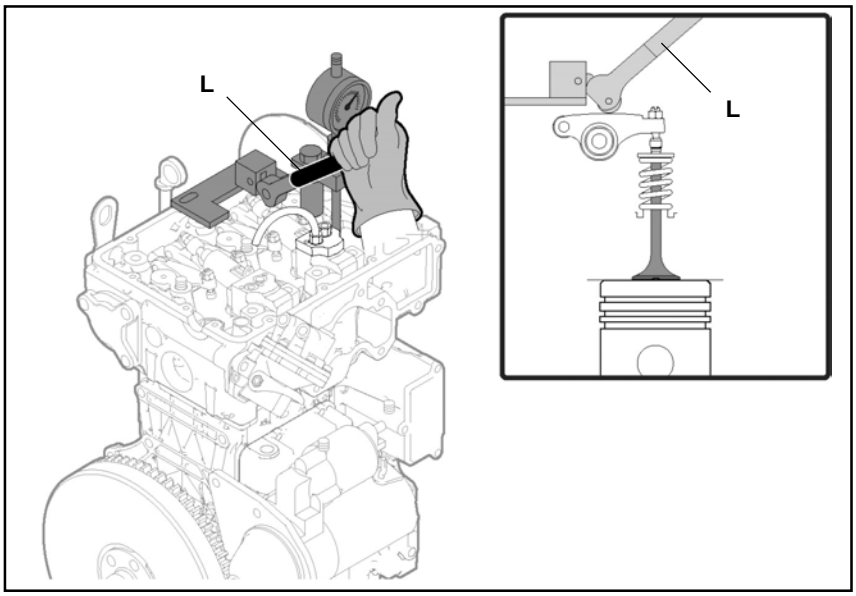
11 - Place the auxiliary tank at a height higher than that of the injectors (~30-40) cm.

12 - Connect the tank to union **(H**).



13 - Rotate slowly the crankshaft clockwise keeping the lever **(L)** lowered and the valve set on the piston crown, until the dial indicator shows the maximum measurement.

14 - Set the dial indicator to zero. In these conditions, the compression top dead centre can be identified.



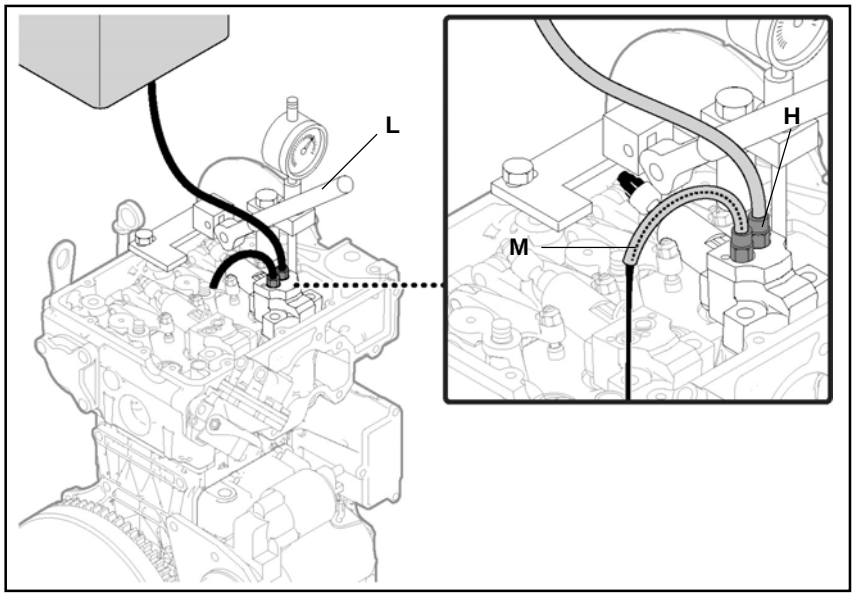
16 - Rotate the crankshaft anticlockwise until liquid leaks from the pipe **(M)**, and then stop turning when the flow is constant and without air bubbles.

17 - Then turn slowly the crankshaft clockwise in order to identify the exact point at which liquid stops leaking.
In these conditions, the point which coincides with the static injection timing can be identified.

18 - Act again on lever **(L)** to lower the valve and bring it again on the piston.

19 - Measure the piston lowering value by using the dial indicator.

20 - Convert the value registered from millimetres to degrees (see "Conversion table for establishing injection timing").



Important

- **When converting, refer to the table value that is nearest to the registered one (see "Conversion table for establishing injection timing").**
- **For a good engine operation, the injection static advance must be as follows:**
- **Engine with maximum speed up to 3000 rpm: 13° (± 1°)**
- **Engine with maximum speed above 3000 rpm: 15° (± 1°)**

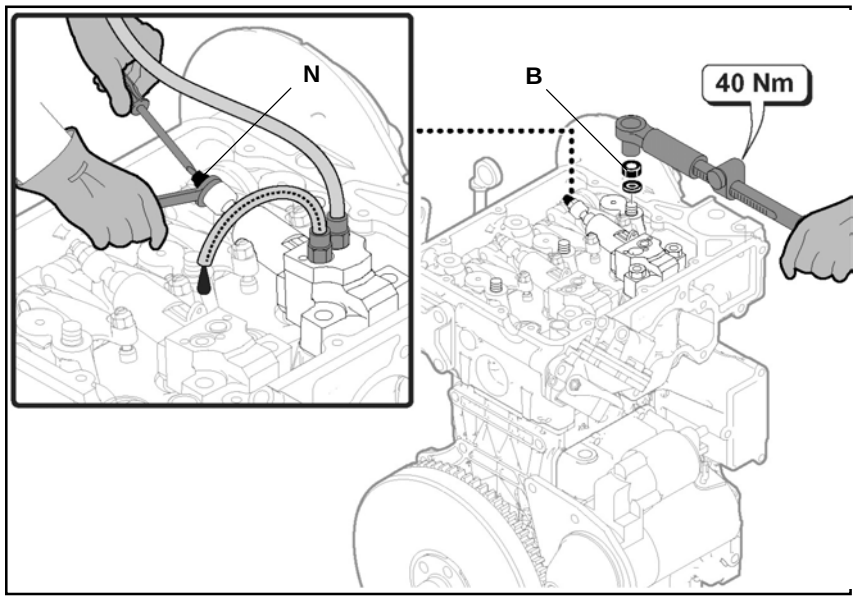
Conversion table for establishing injection timing

mm	injection advance angle	mm	injection advance angle
1,947	18°	0,733	11°
1,739	17°	0,606	10°
1,543	16°	0,491	9°
1,358	15°	0,388	8°
1,184	14°	0,297	7°
1,022	13°	0,218	6°
0,871	12°		

If the static advance does not correspond to the ideal values, change the adjustment by means of the screw **(N)**.

To increase the angular value (higher static advance), turn the screw clockwise.

To decrease the angular value (lower static advance), turn the screw anticlockwise.



Important

Half turn of the screw equals approximately 5° of static angular advance.

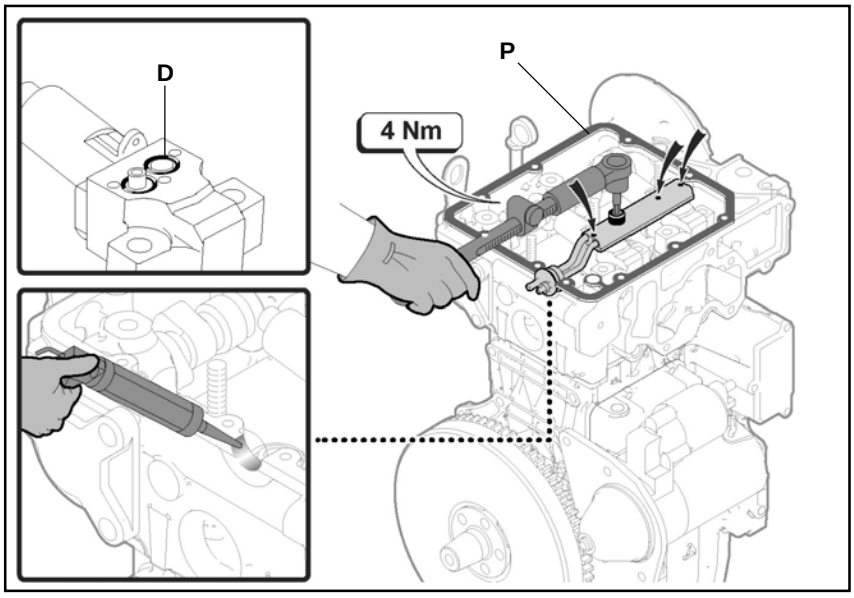
21 - Disassemble all equipment when the injection static advance is reached.

22 - Fasten and tighten the nut **(B)** to a final torque of 40 Nm.

Important

Repeat on the other cylinder.

23 - Once adjustment is finished, assemble the new O-rings **(D)** on the injector pumps.



Important

The O-rings must always be replaced with original spare parts whenever the fuel rail is disassembled.

24 - Apply some silicone sealant on the fuel rail seat.

25 - Assemble the fuel rail and fasten the screws without tightening them.

26 - Tighten the screws to a final torque of 4 Nm.

27 - Slip on a new gasket **(P**).

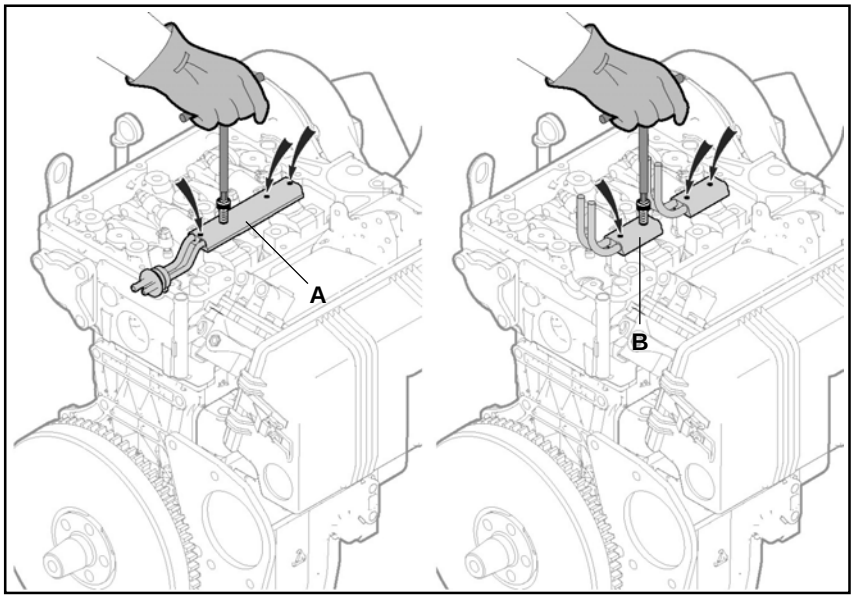
28 - Reassemble the rocker arm cover (see "Assembling the rocker arm cover").

6.7 BALANCING THE INJECTION-PUMP DELIVERY

Importante

It is necessary to balance delivery whenever the injection-pump is replaced.

In order to work on the injector, it is necessary to remove the rocker arm cover.
See "Disassembling the rocker arm cover" for the correct procedure.

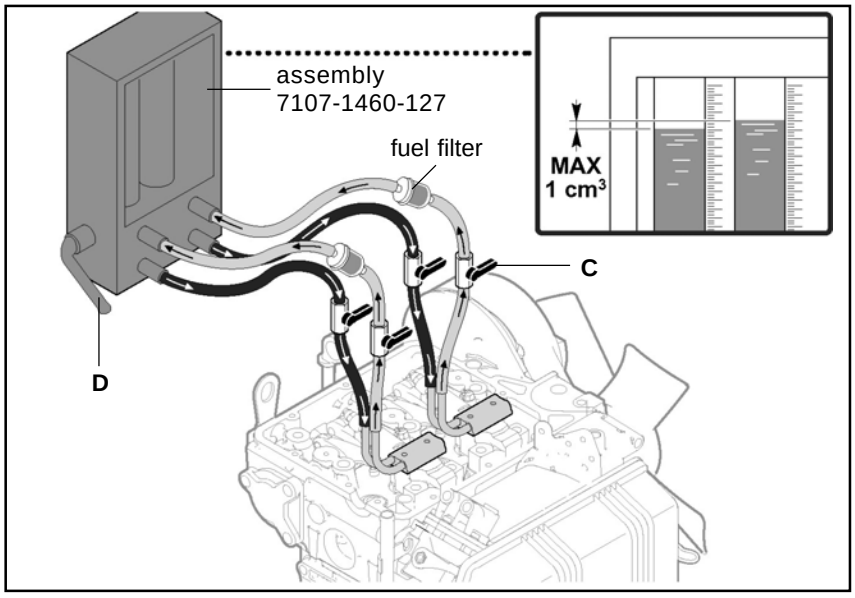


1 - Remove the fuel rail **(A)**.

2 - Mount the "7107-1460-127" tool heads **(B).**

3 - Position the assembly “7107-1460-127" above the height of the injectors.

4 - Connect the outlet and intake pipes of the assembly to the test heads.



Important

Be careful not to reverse the intake and outlet pipes when connecting.

5 - Open the cocks **(C**).

6 - Start the engine and keep it at minimum idle speed (~ 1150÷1250 Rpm).

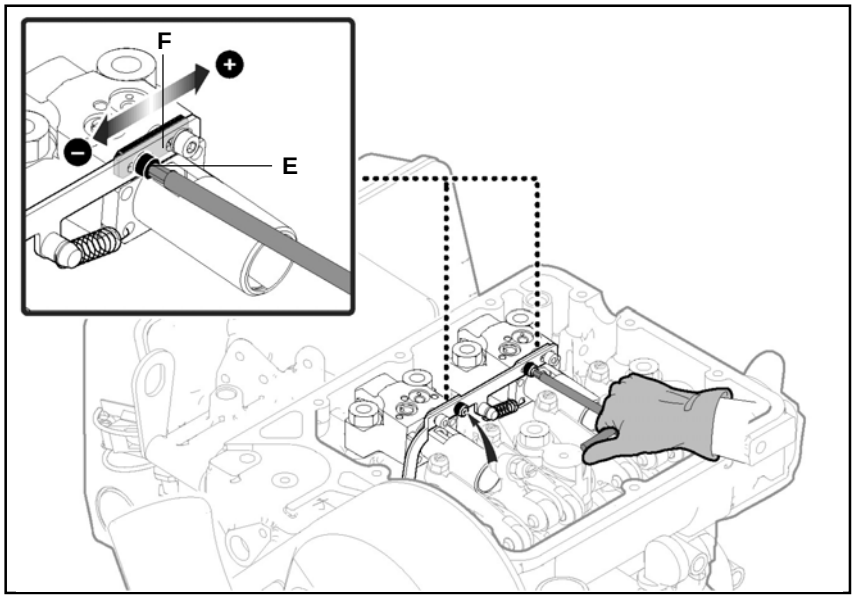
7 - Turn the equipment switching valve by means of the lever **(D**).
(The engine is supplied by tubes and no more by tool tank).

8 - Check the level of the test heads after 1 minute.

9 - Make sure the difference in volume is no greater than 1 cm³.

Important

If the difference is greater, increase delivery of the injector pump with the highest level, or reduce the one with the lowest level.



10 - Loosen the screw **(E)** to adjust delivery at the injector.
11 - Shift the plate **(F)** gently in one of the two directions. Shift the plate towards the flywheel to increase delivery. Shift the plate towards the timing belt to reduce delivery.
12 - Tighten the screw **(E)** to a torque of 1.1Nm.
13 - Close the cocks and disconnect the assembly.
14 - Put the new O-rings on the injector pumps.
15 - Apply sealant to the seat of the fuel rail.

Important

The O-rings must always be replaced with original spares whenever the fuel rail is disassembled.

16 - Assemble the fuel rail and fasten the screws without tightening them completely.
17 - Tighten the screws to a torque of 4Nm..

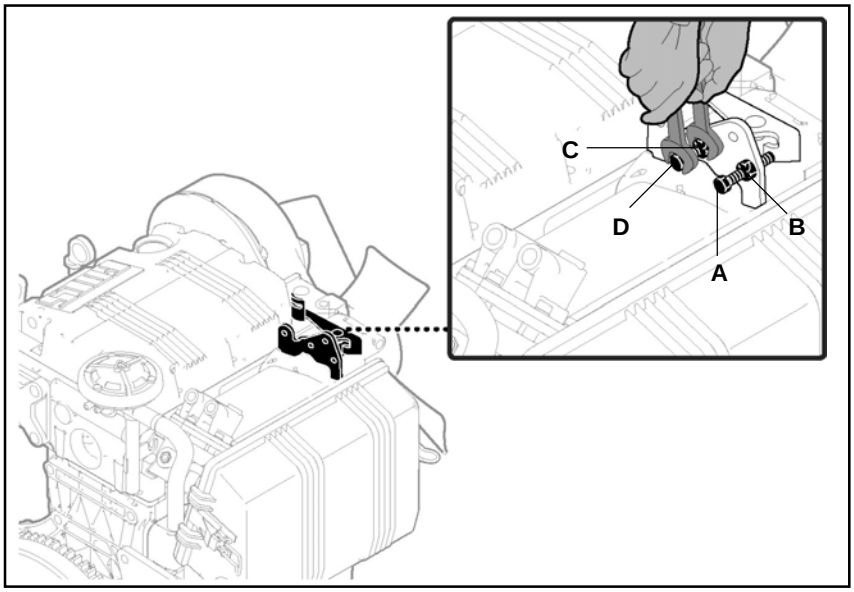
6.8 ADJUSTING MINIMUM AND MAXIMUM IDLE SPEED RPMS

1 - Connect a revolution counter to the engine.

2 - Run the engine and bring it to the operating temperature.

3 - Turn the idle adjusting screw **(A)** and set the engine to the minimum speed required.

4 - Tighten the lock nut **(B)** when finished.



Important

To decrease the rpm number, loosen the screw. To increase it, tighten the screw.

5 - Turn the peak-rpm adjusting screw **(D)** and set the engine to the maximum speed required.

6 - Tighten the lock nut **(C)** when finished.

Important

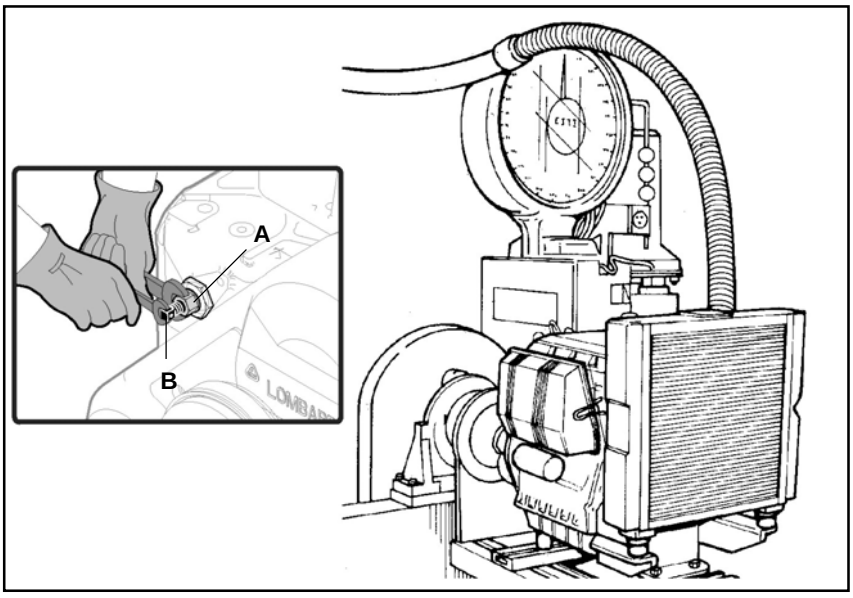
To decrease the rpm number, tighten the screw whereas to increase it loosen the screw.

6.9 ADJUSTING INJECTION DELIVERY

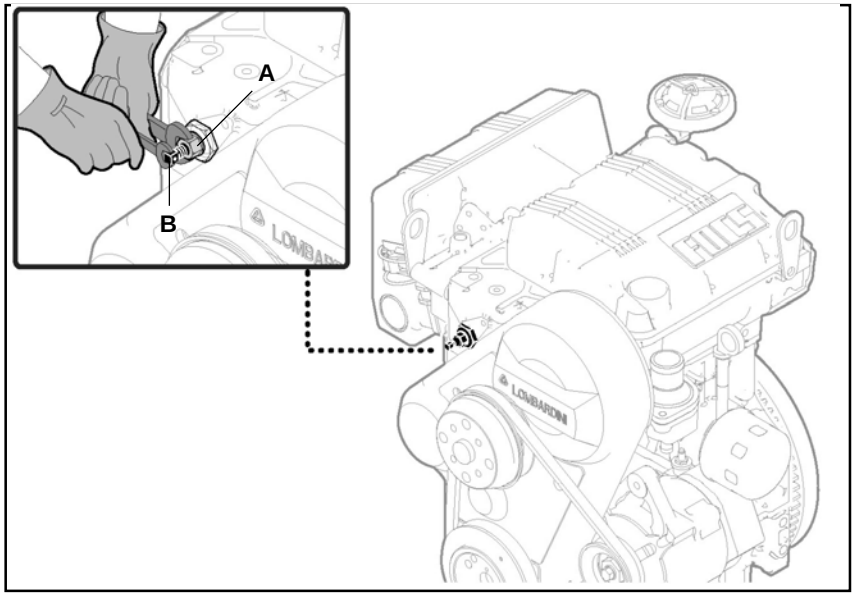
The adjustment may be performed with the dynamometric brake (accurate adjustment) or without it (approximate adjustment).

6.9.1 Adjusting injection delivery (without dyno break)

1 - Loosen locknut **(A**).
2 - Firmly tighten the screw **(B)** of the flow limiter.
3 - Start the engine and bring it to the operating temperature.
4 - Bring the engine to maximim rpm allowed.
5 - Loosen the screw **(B)** of the flow limiter until the engine speed starts to decrease.
6 - Retighten the screw rotating it 2.5 revolutions, then fasten with the lock nut **(A**).



6.9.2 Adjusting injection delivery (with dyno break)



1 - Start the engine and bring it to the operating temperature.

2 - Bring the engine to maximim rpm allowed.

3 - Loosen the locknut **(A**).

4 - Firmly tighten the screw **(B)** of the flow limiter.

5 - Activate the dyno brake to bring the engine to maximum power and speed.

6 - Make sure that fuel consumption corresponds to the recommended values (see "Table of specific fuel consumption"). If fuel consumption does not correspond to the values shown, reduce the load of the dyno brake.

7 - After a few minutes of running the engine and when it has "stabilised", slowly unscrew the limiter screw **(B)** until the speed starts to decrease.

8 - Fasten the screw **(B)** with the locknut **(A**).

9 - Deactivate the dyno brake and take note of the "stabilized" engine speed.

10 - Switch off the engine and leave to cool.

11 - Check the valve-rocker arm clearance (see "Adjusting valve/rocker arm clearance").

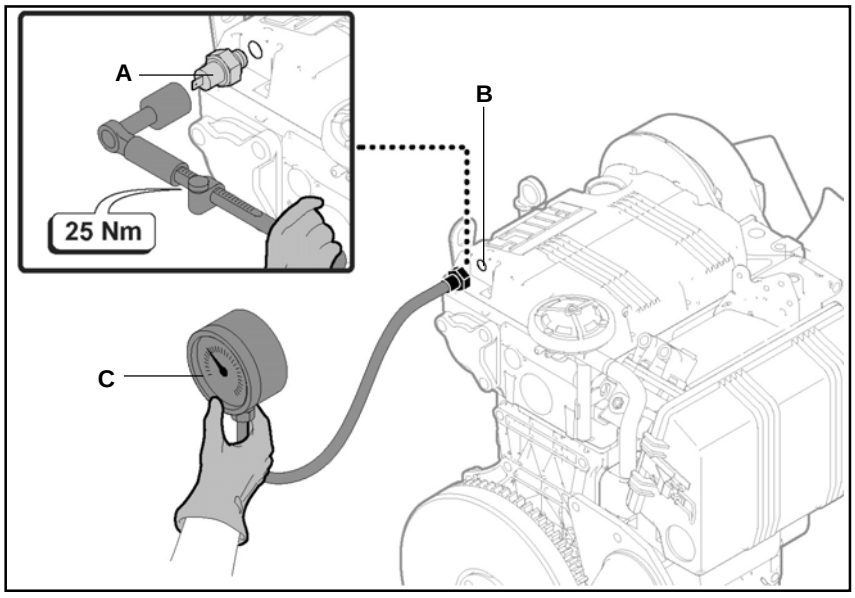
Important

If the engine gives off too many fumes at maximum load, loosen the flow limiter screw. If it gives off no fumes or does not achieve maximum power, tighten the flow limiter screw.

Table of specific fuel consumption

Motor speed	Power curve NB(a)	Specific fuel consumption	
Rpm	Kw	Time-secs. per 100 cc	g/Kwh
2200	5,51	192÷183	285÷299
3000	7,38	125÷129	315÷325
3600	7,72	120÷115	326÷340

6.10 CHECKING OIL PREASSURE



1 - Remove the preassure switch **(A**).
2 - Mount a union in the hole **(B)** and connect to a 10-bar pressure gauge **(C)**.
3 - Start the engine and bring it to the operating temperature.
4 - Start the engine and bring it to a speed of 900 RPM, while at the same time making sure that the pressure gauge shows a pressure of 1 bar (oil temperature 80÷120 °C).
5 - Switch off the engine.
6 - Remove the pressure gauge **(C)** and the union **(B**).
7 - Replace the pressure switch **(A)** and tighten it to a torque of 25Nm.

7.1 RECOMMENDATIONS FOR INSTALLING THE ASSEMBLIES

– Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.

– This chapter describes procedures for installing assemblies and/or individual components that have been checked, overhauled or replaced with original spare parts.

Important

To locate specific topics, the reader should refer to the index.

– The operator must wash, clean and dry components and assemblies before installing them.

– The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.

– Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.

– For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.

– Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.

– In order to fix assemblies and/or components securely, the operator must tighten the fastening parts in a criss-cross or alternating pattern.

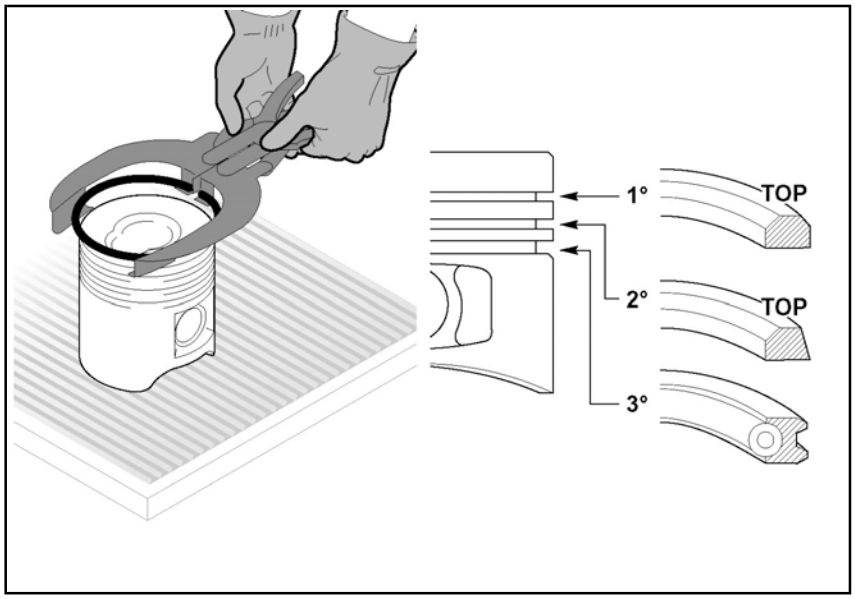
– Assemblies and/or components with a specific tightening torque must initially be fastened at a level lower than the assigned value, and then subsequently tightened to the final torque.

7.2 PRE-ASSEMBLY OF SEALING RINGS-PISTONS

– Thoroughly clean the pistons and lubricate the coupling areas.
– Put the sealing rings on the piston in the order shown in the figure.

Important

– **Place the sealing rings with the markings facing up towards the upper part of the piston (crown).**
– **Keep the pistons together with their own connecting rods and wrist pins.**



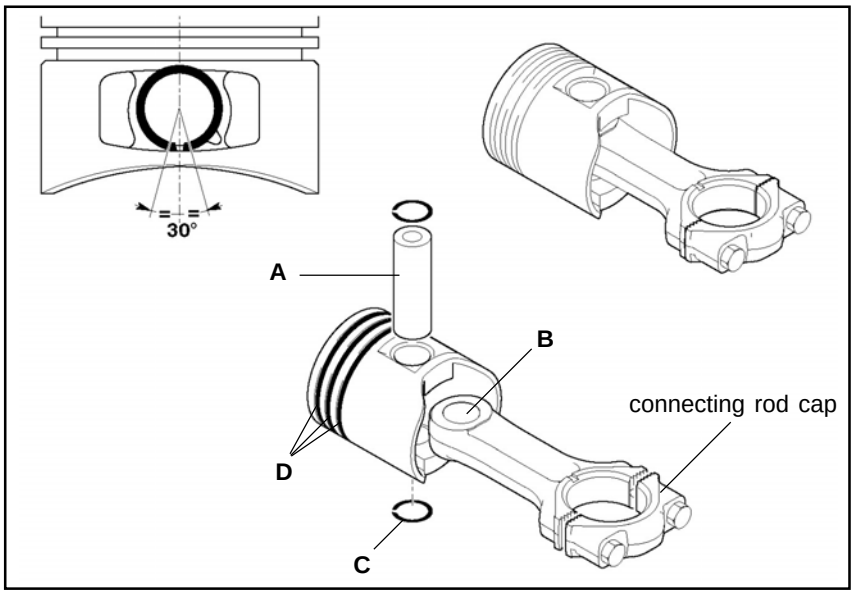
7.3 PRE-ASSEMBLY OF CONNECTING RODS - PISTONS

Important

Before pre-assembly, check that the weight difference between the two connecting rod-piston-wrist pin assemblies does not exceed 10 g to prevent weight imbalances.

1 - Lubrificate the wrist pin **(A)** and the seat of the small end of the connecting rod **(B)**.

2 - Place the lock ring **(C)** on the piston complete with sealing rings **(D)**.



Important

Insert the lock rings with the tips pointing towards the base of the piston with a tolerance of 15°.

3 - Insert the wrist pin **(A)** into the piston **(D)** and install the connecting rod **(B)** (complete with cap).

4 - Insert the wrist pin completely and fasten with the lock ring.

Important

- **Make sure the lock rings are positioned correctly in their seats.**
- **Lubricate the coupling parts and those that are prone to oxidation.**

7.4 INSTALLING VALVES

7.4.1 Assembling the valves

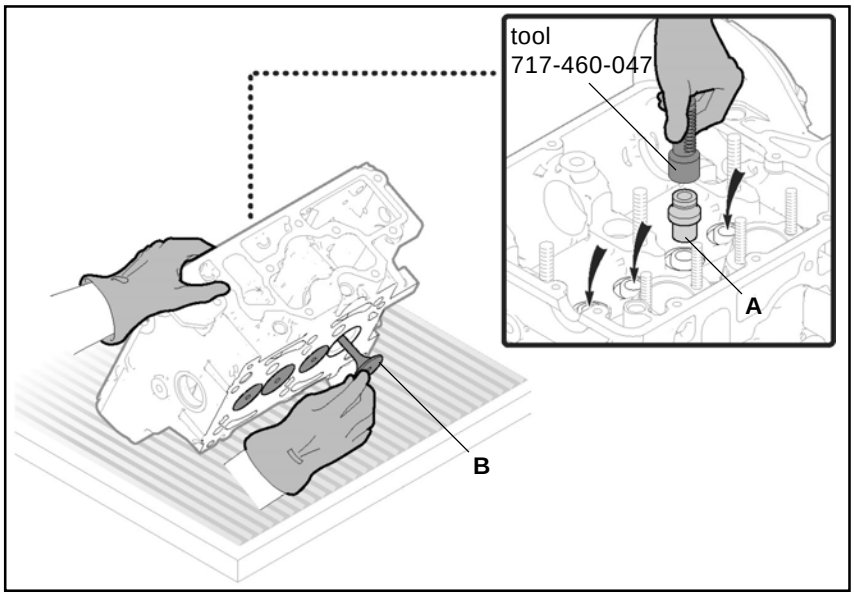
Important

- **Make sure that the cylinder head is perfectly clean and dry.**
- **Check that all components are intact and, if necessary, replace them with original spares.**

1 - Lubrificate the valve stem sealing ring **(A)**, insert it into tool “717-1460-047”, and mount it right into the seat of the valve guide.

2 - Lubrificate the vale stem **(B)**.

3 - Slip the valve into the seats.

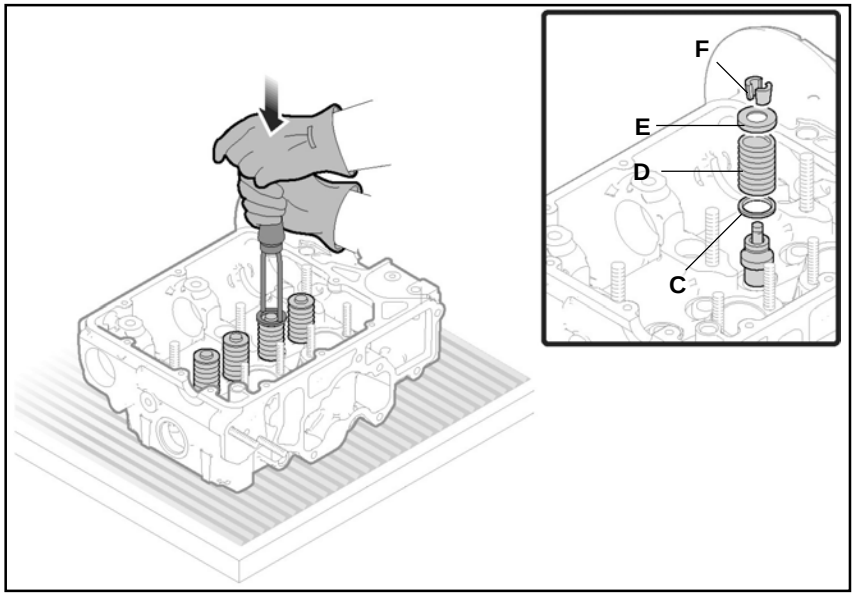


4 - Mount the collar **(C)**, the spring **(D)**, the cup **(E)** and the half collets **(F)**.

5 - Press down hard on the cup **(E)**, using the special tool "7107-1460-047" to insert the half collets **(F)** into the valve stem groove.

6 - Release the tool and check that the half collets are positioned correctly.
If the half collets are not correctly positioned, repeat the operation.

7 - Repeat the same operation on the other valves.



7.5 INSTALLATION OF CRANK GEAR AND CRANKCASE

7.5.1 Installing piston/connecting rod - engine block

Important

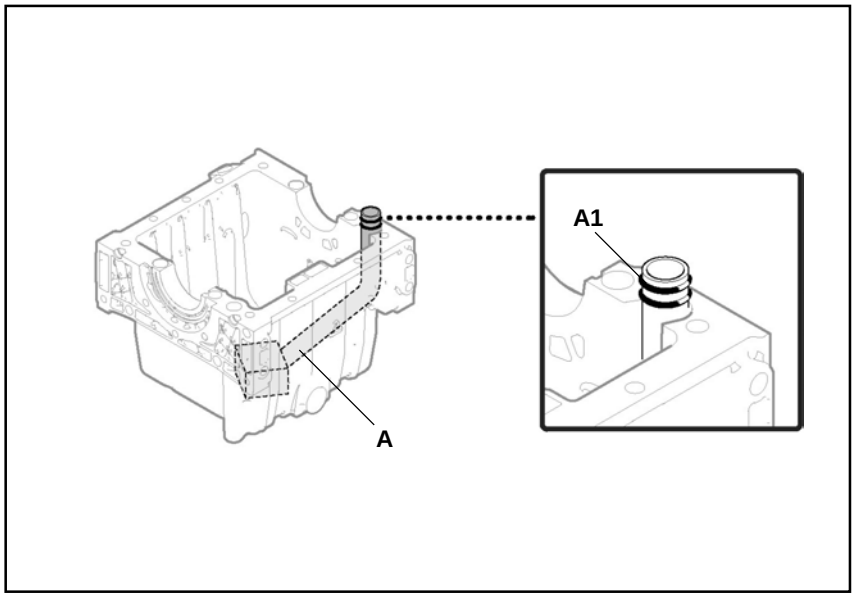
Make sure that the engine block and the crankcase are perfectly clean and dry.

1 - Assemble the pipe **(A)** with the oil suction filter.

2 - Mount the new O-rings **(A1)**.

3 - Carefully clean and lubricate the cylinders and the connecting rod-piston assembly (**B**).

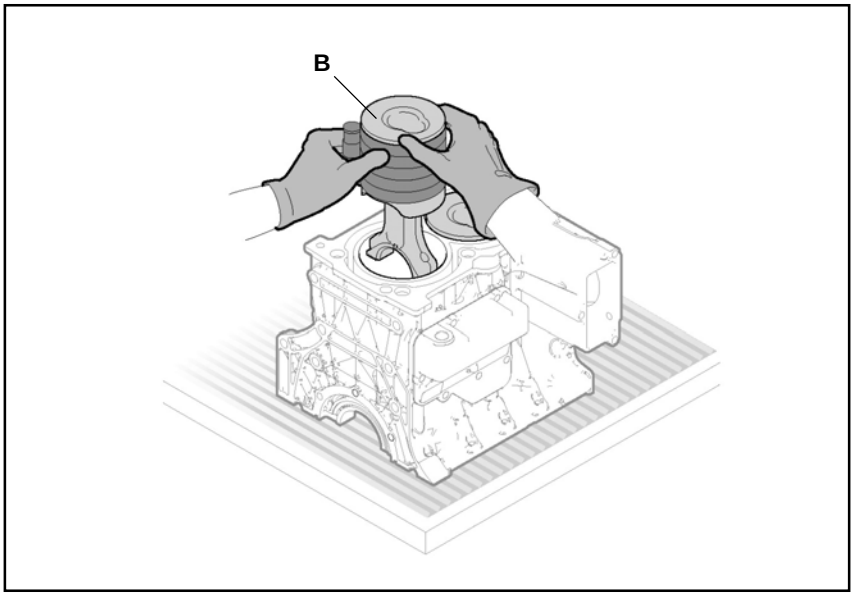
4 - Rotate the sealing rings so that the cuts have a displacement of about 120° between them.



Important

In order not to damage the sealing rings and the contact areas while inserting the piston into the cylinder, use the special containment device.

5 - Mount the connecting rod-piston assembly **(B)** onto the engine block and position the connecting rod big ends along the axis of the crankshaft.



Important

The piston combustion chamber must be assembled on the precombustion chamber.

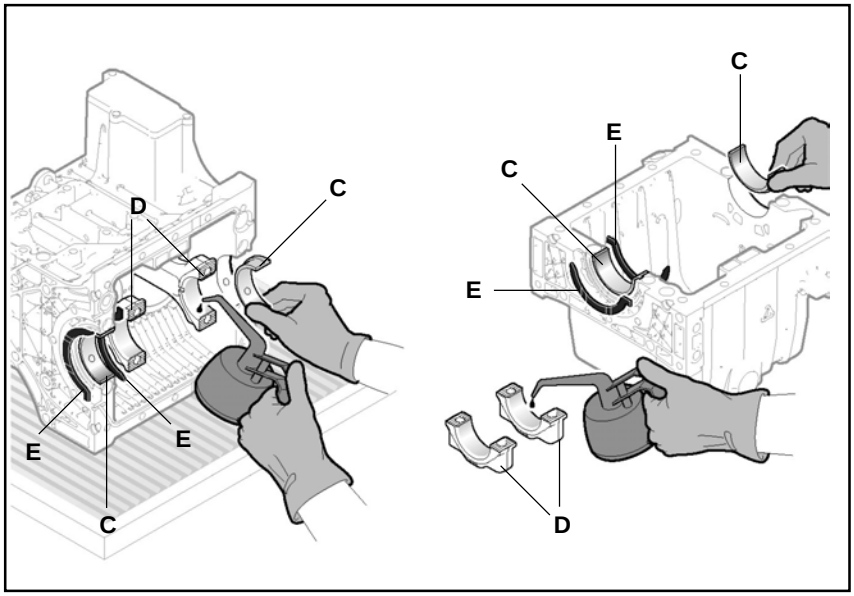
7.5.2 Assembling the crankshaft

1 - Mount the half-bearings **(C)** and the standard shoulder half-rings **(E)** (flywheel side).

Important

- **Follow the marks made during the removal phase.**
- **The shoulder half-rings must be placed with the lubrication grooves facing outwards.**

2 - Lubrificate the half-bearings **(C**), the connecting rod big ends **(D)** and caps **(F**).
3 - Carefully lubricate the crankshaft main journals and crank pins.



4 - Assemble the crankshaft **(G**).

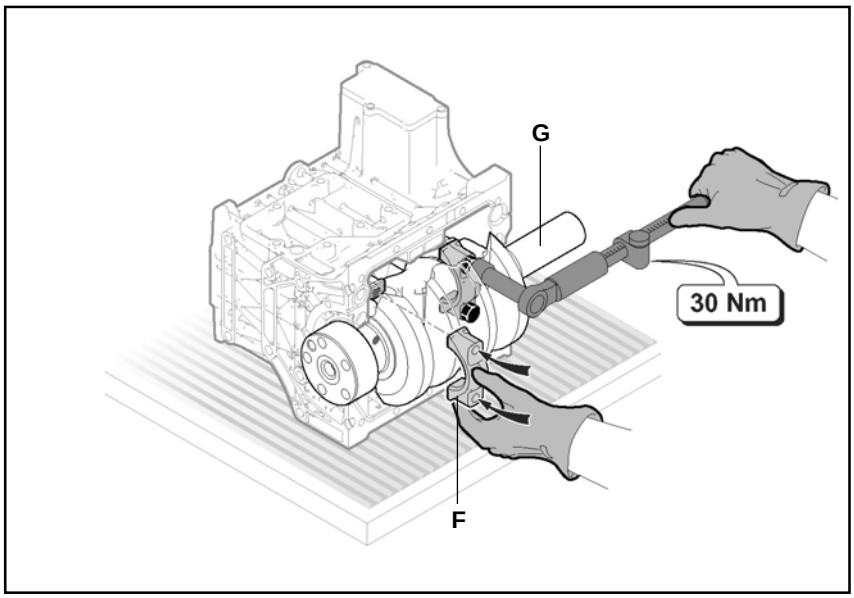
5 - Replace the connecting rod caps **(F)** and put in the screws.

6 - Tighten the connecting rod cap screws to a temporary torque of 25Nm.

7 - Tighten the connecting rod cap screws to a final torque of 30Nm.

8 - Assemble the crankcase (see "Assembling the crankcase").

9 - Measure the axial clearance of the crankshaft (see "Measuring crankshaft axial clearance").

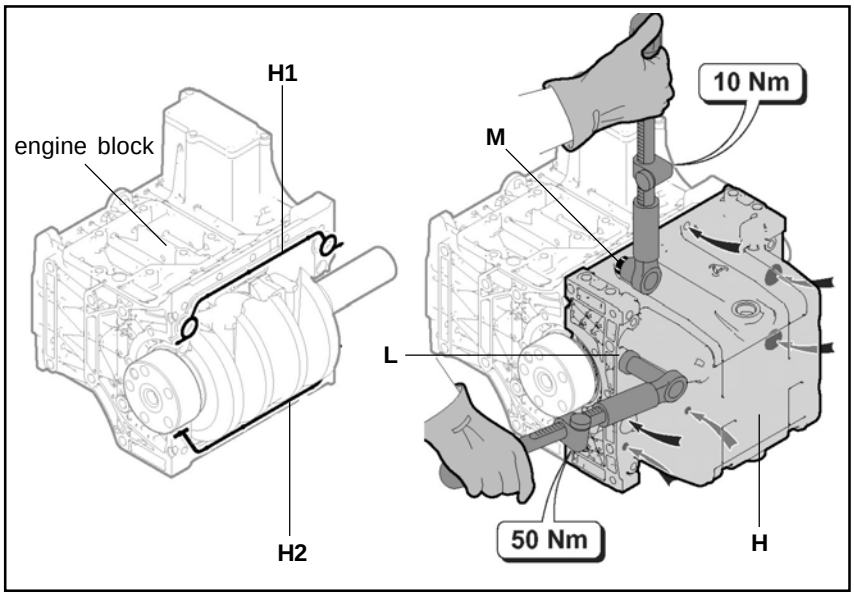


7.5.3 Assembling the crankcase

Important

- **Make sure that the contact surfaces and related pins are perfectly intact and clean.**
- **Make sure there are no foreign bodies or residual material in the engine block and crankcase.**

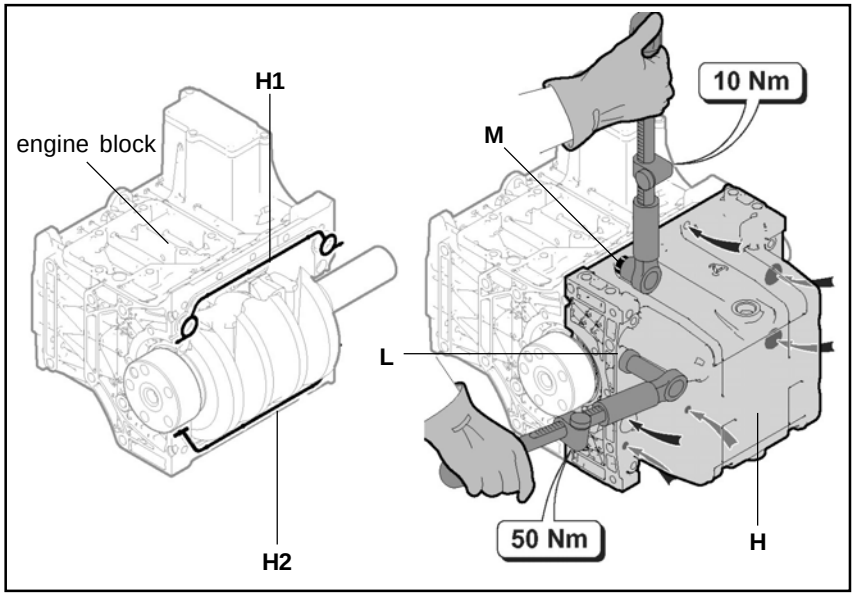
1 - Mount the new gaskets **(H1- H2)** for the engine block contact surface with the crankcase.
2 - Replace the crankcase **(H)** and put in the screws **(L-M**).
3 - Tighten the screws **(L)** temporarily in a crisscross pattern.



4 - Tighten the screws **(M)** temporarily in alternating pattern.

5 - Tighten the screws **(L)** in a crisscross pattern to a final torque of 50Nm.

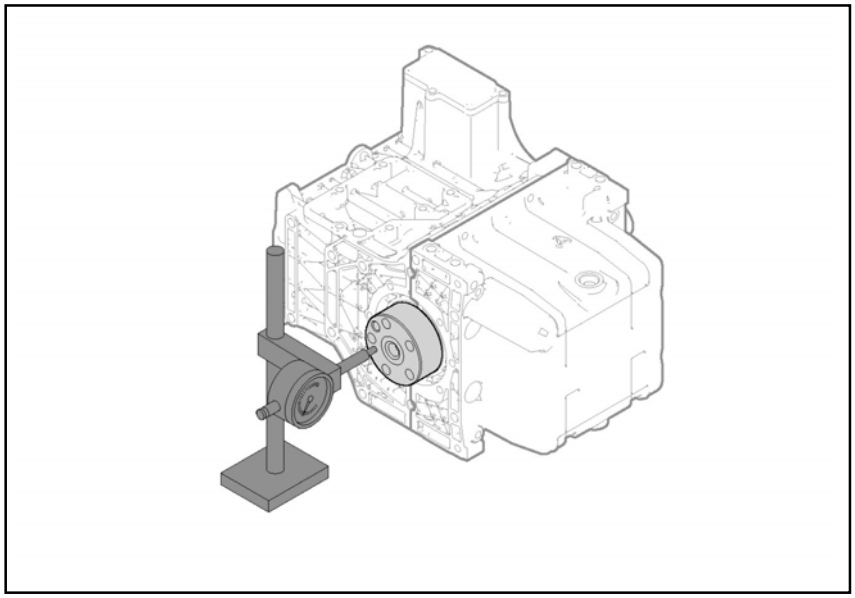
6 - Tighten the screws **(M)** in an alternating pattern to a final torque of 10Nm.



7.5.4 Measuring crankshaft axial clearance

To measure the axial clearance of the crankshaft, it is necessary to assemble the shaft complete with crankcase.
See "Assembling the crankcase" for the correct procedure.

1 - Using a dial indicator, measure the axial shift of the crankshaft.
Axial shift must be between 0.130 and 0.313mm. If axial shift is above these values, it is necessary to insert uprated shoulder half-rings and once again disassemble the crankcase (see "Dimensional check and overhaul of crankshaft").



7.5.5 Assembling the crankshaft flange (flywheel side)

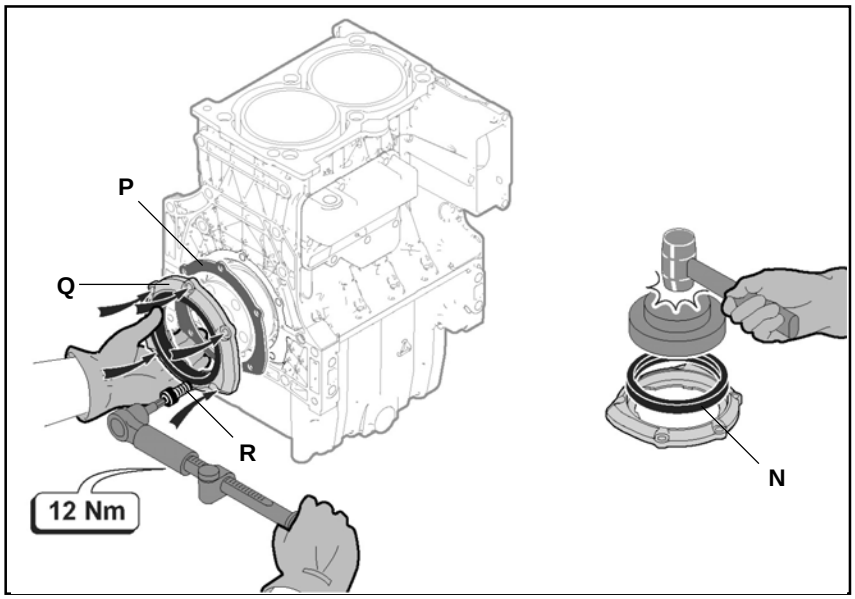
1 - Clean the flange and the sealing ring seat **(N)**.

2 - Using the special pad, insert a new sealing ring **(N)** into the flange **(Q)**.

Important

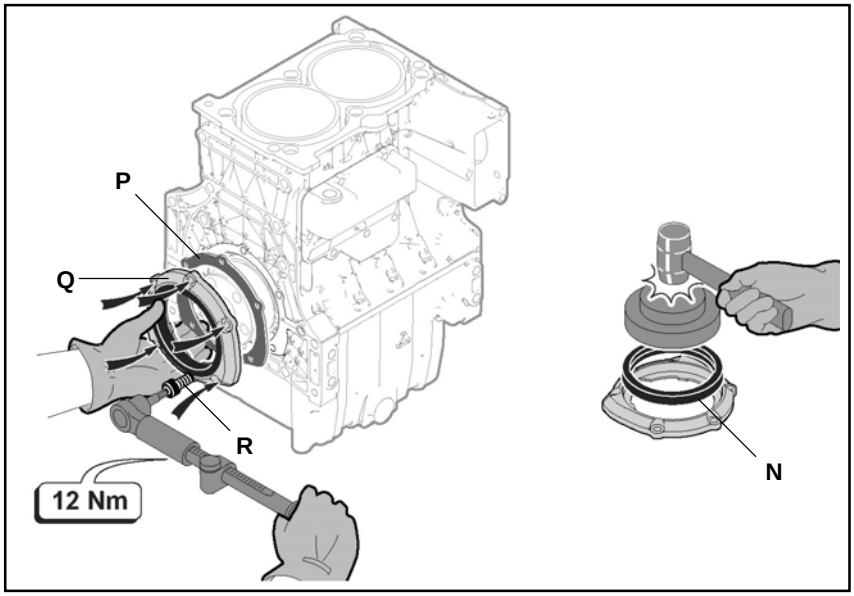
Given the particular function played by this sealing ring, it is important to use only original spares.

3 - Check that the contact surfaces are perfectly clean and intact.



4 - Slip on a new gasket **(P)**.

5 - Replace the falnge **(Q)** and put in the screws **(R)**.



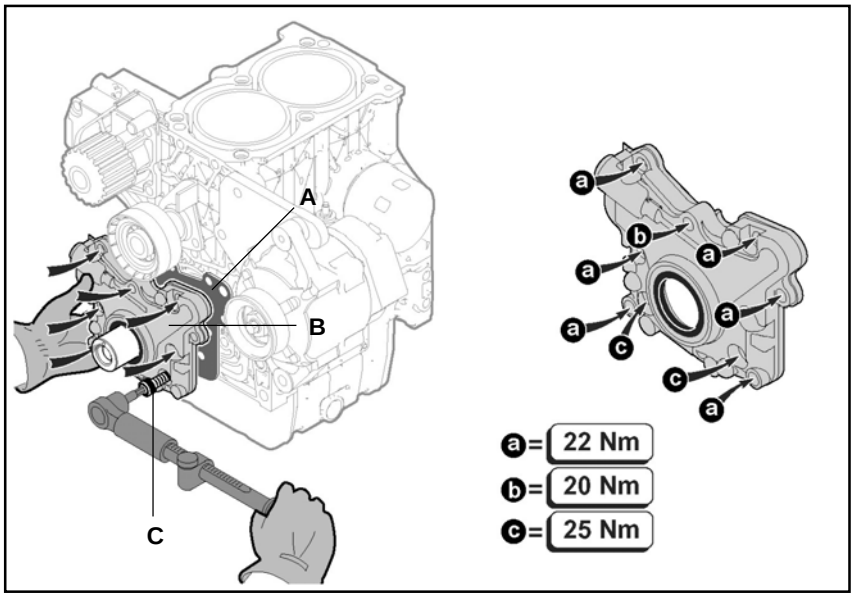
Important

Be careful not to damage the sealing rings during this operation.

6 - Tighten the screws **(R)**, in a crisscross pattern to a final torque of 12Nm.

7.5.6 Installing the oil pump

Before installing the oil pump, make sure there are no malfunctions (see “Check and overhaul the oil pump”).



Important

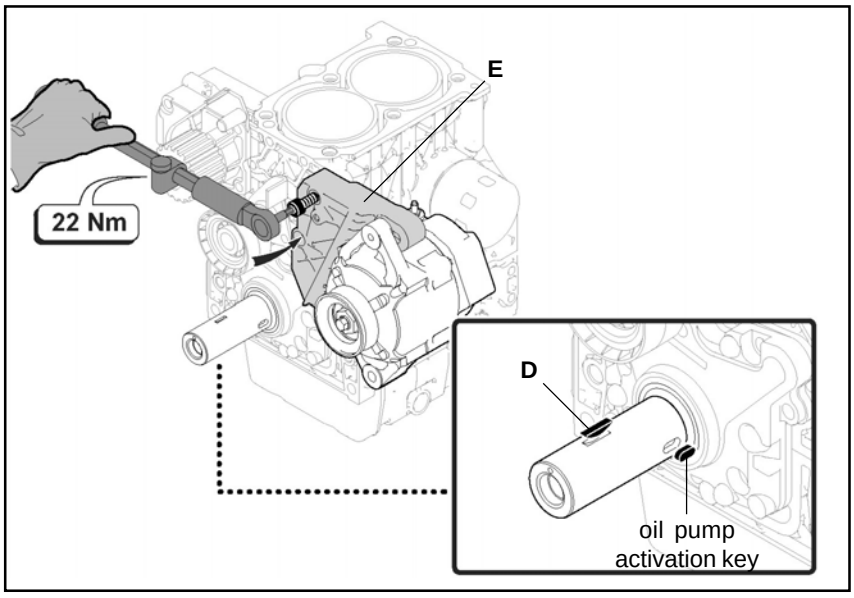
Check that the contact surfaces are perfectly clean and intact.

1 - Slip on a new gasket **(A)**.

2 - Insert the oil pump activation key into the crankshaft.

3 - Bring piston number one (flywheel side) to the top dead centre, with the oil pump activation key in line with break in the flange, in order to be able to assemble the pump.

4 - Install the pump **(B)** and put in the screws **(C)**.



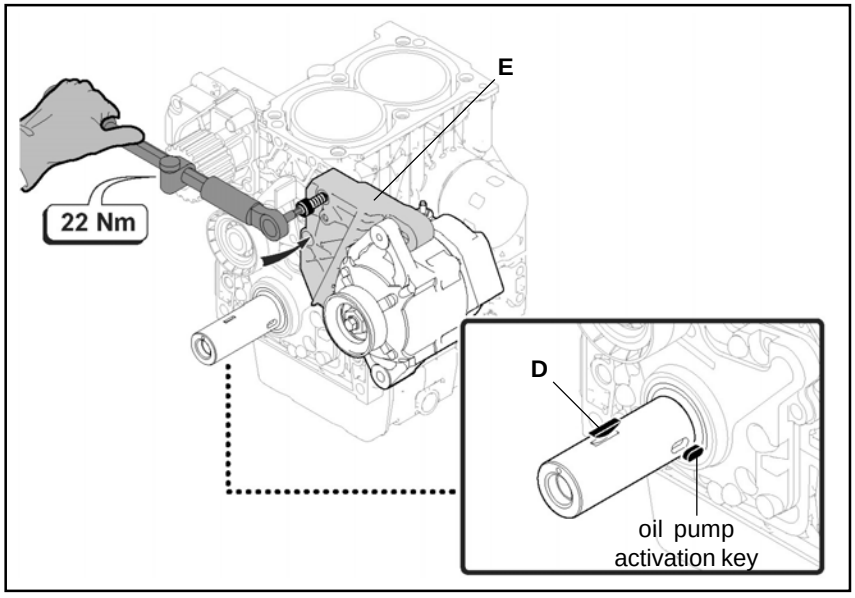
Important

Be careful not to damage the sealing rings during this operation.

5 - Tighten the screws in a crisscross pattern, and tighten each of them to their respective final torques (see image).

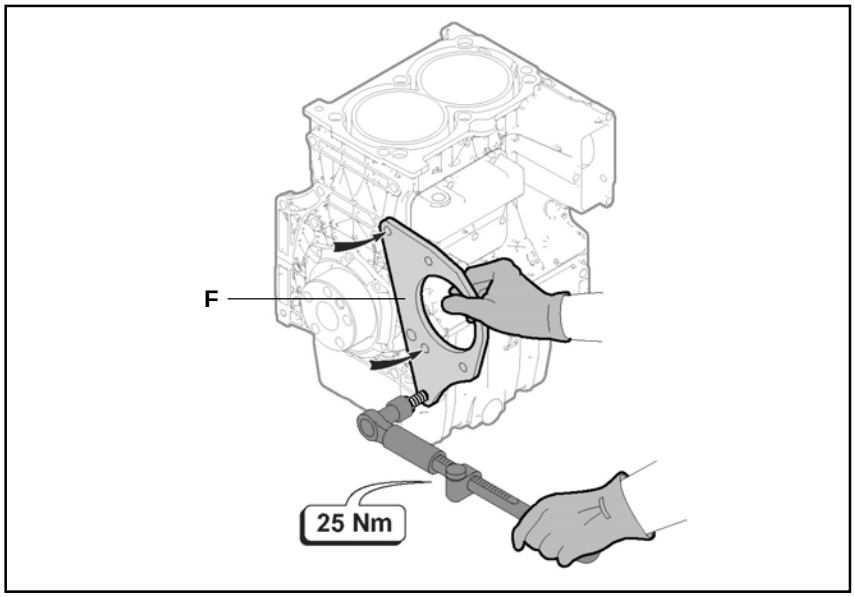
6 - Insert the key **(D)** into the crankshaft.

7 - Install the alternator support **(E)** and tighten the screws to a torque of 2.2Nm.



7.5.7 Assembling the flywheel

1 - Install the support **(F)** and tighten the screws to a torque of 25 Nm.



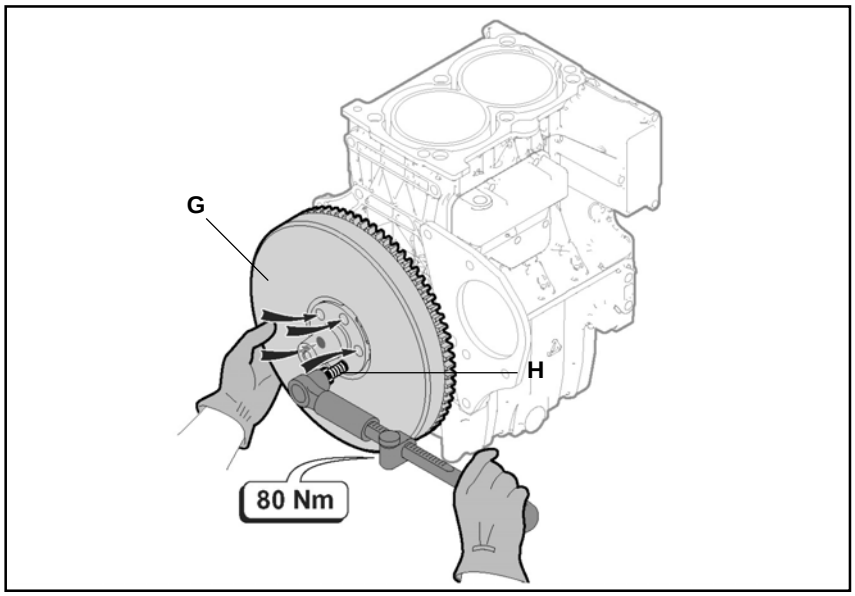
2 - Install the flywheel **(G)** and put in the screws **(H)**.

3 - Tighten the screws temporarily in a crisscross pattern.

4 - Tighten the screws in a crisscross pattern to a final torque of 80Nm.

Important

Turn the flywheel manually to check the movement of the mechanical parts.



7.6 INSTALLATION OF CYLINDER HEAD AND COMPONENTS

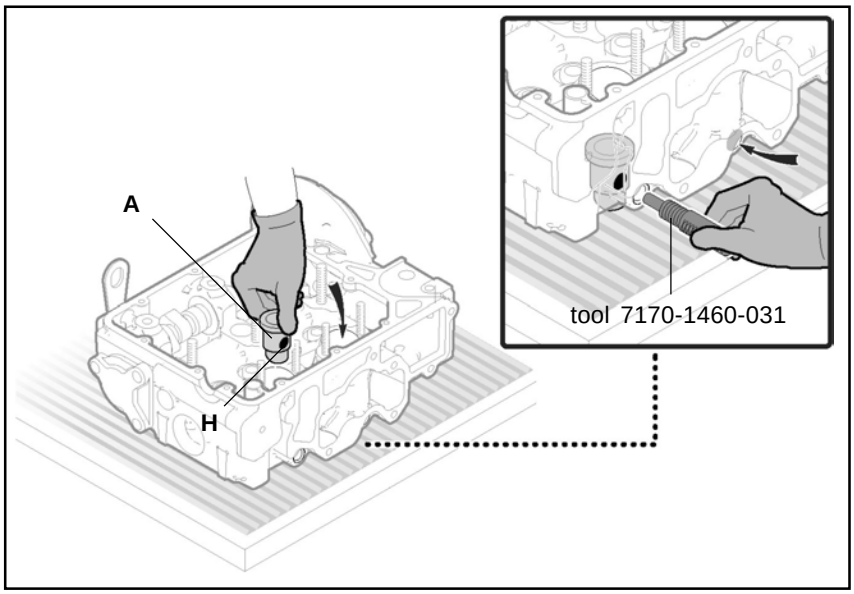
7.6.1 Assembling the precombustion chamber

Important

Check that the contact surfaces are perfectly clean and intact.

1 - Install the precombustion chamber **(A**), so that its hole coincides with the one on the pre-heating glow plug.

2 - Insert tool "7107-1460-031" into the seat of the preheating glow plug in order to lock the chamber while the ring nut **(B)** is being tightened.



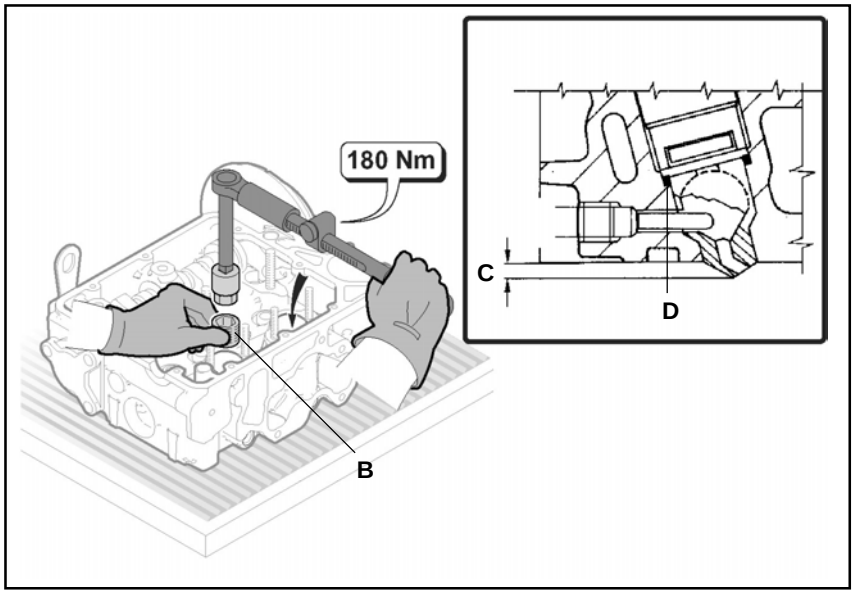
3 - Apply some anti-seize product to the ring nut thread (**B**) and to the surface that is in contact with the precombustion chamber.

4 - Mount the ring nut **(B**).

5 - Tighten the ring nut to a temporary torque of 100Nm.

6 - Make sure that the precombustion chamber protrusion **(C)** is between 3.56÷4,04 mm. If the protrusion **(C)** exceeds the recommended value, insert a shim **(D)** (provied ad spare part) beneath the precombustion chamber **(A**).

7 - Tighten the ring nut to a final torque of 180Nm.

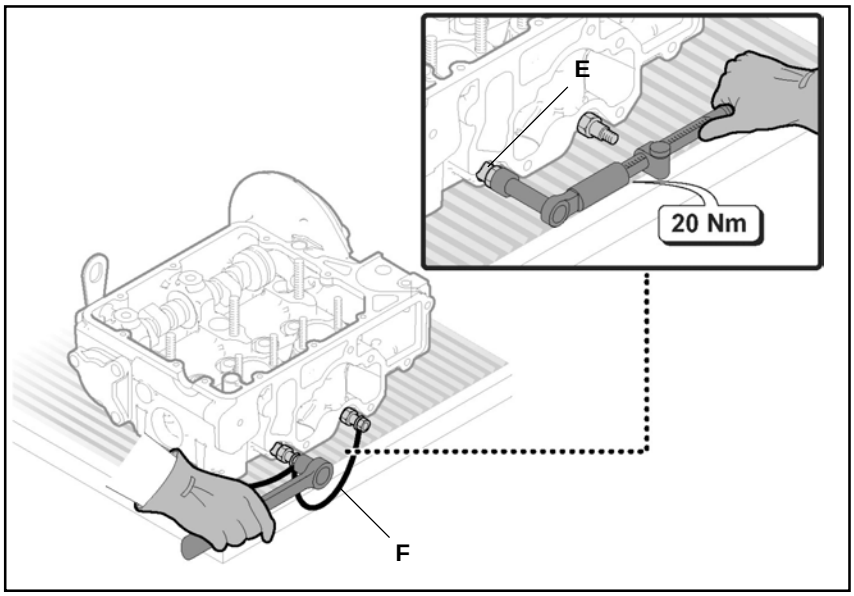


8 - Remove the tool and install the preheating glow plug **(E**).

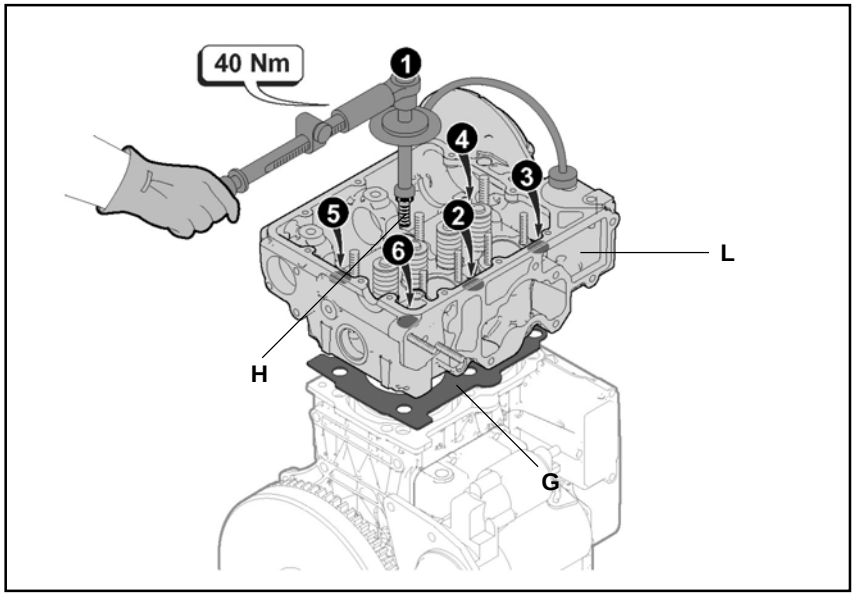
9 - Tighten the glow plug to a torque of 20 Nm.

10 - Repeat the same operations on the other chamber.

11 - Connect the glow plug power supply cable **(F)**.



7.6.2 Assembling cylinder head



Important

- **Make sure there are no foreign bodies or residual material in the cylinder head cavity.**
- **Check that the contact surfaces are perfectly clean and intact.**

1 - Slip on a new gasket **(G**).

2 - Choose the gasket shim to be installed (see “Check clearance volume”)

3 - Make sure that the length of the screws **(H)** does not exceed 92mm, otherwise replace.

4 - Lubricate the screws copiously **(H)**.

5 - Mount the cylinder head **(L)** and put in the screws **(H)**.

6 - Tighten the screws in sequence (see diagram) to a temporary torque of 40 Nm.

Important

If the screws (H) belong to 10.9 class, the tightening torque is 60Nm and it is not necessary to tighten them further.

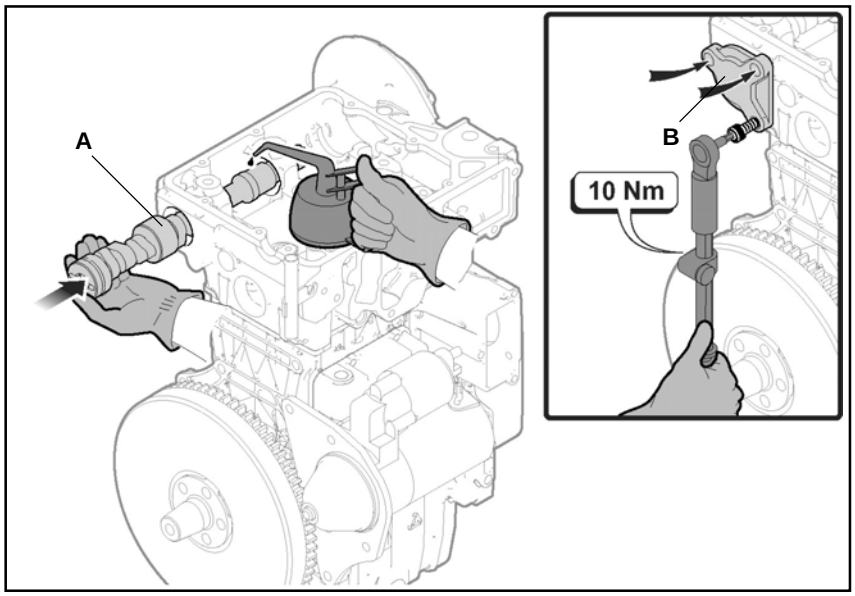
Important

Use a torque wrench with an angle torque tool to tighten the screws.

7 - Tighten the screws further clockwise, rotating 90°.

8 - Tighten the screws to their final torque, rotating 90.

7.6.3 Assembling the camshaft



Important

Make sure that the camshaft and it’s housing are perfectly intact and clean.

1 - Lubricate the camshaft **(A)** and its housing.

2 - Insert the camshaft into its housing.

3 - Mount a new O-ring onto the cover **(B)**.

4 - Mount the cover **(B)** and tighten the screws to a torque of 10 Nm.

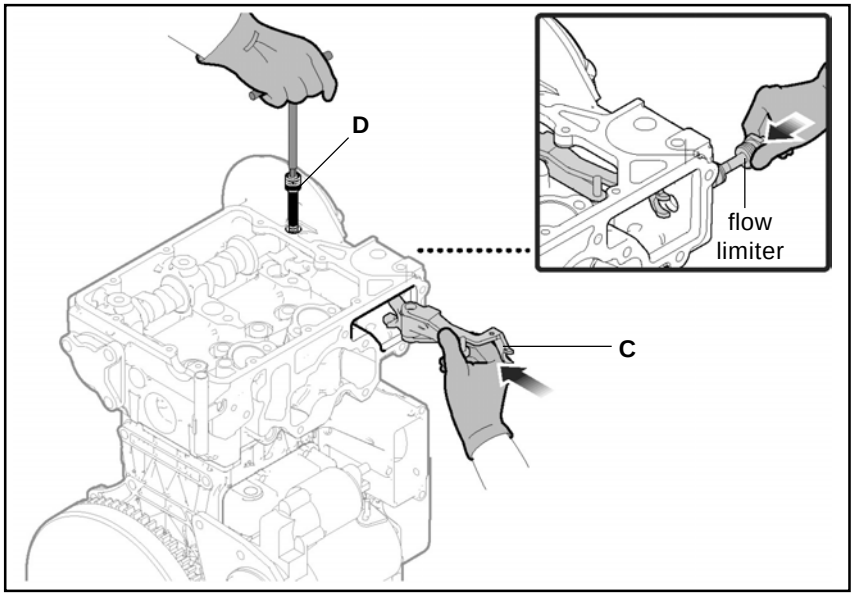
7.6.4 Assembling the speed governor and flow limiter

Important

– Make sure that all components are perfectly clean and dry.
– Check that all components are intact and, if necessary, replace them with original spares.

1 - Mount the levers **(C)** and pivot them with the screw **(D)** to a torque of 0.70 Nm.

2 - Install the flow limiter.



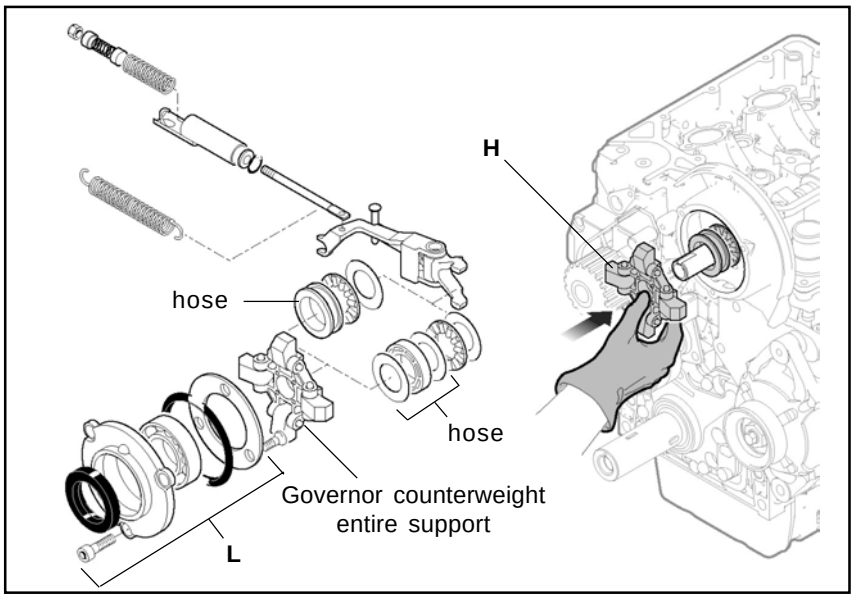
3 - Mount the rotation components onto the camshaft.

Important

The rotation components are produced in several versions. Consult the diagram when mounting.

1 - Mount the weights assembly **(H)** onto the camshaft.
Carry out this operation with the weights open so that they close on the flat part of the spacing collar.

2 - Check that all the components of the cover **(L)** are intact and, if necessary, replace them with original spares.



Important

Make sure that the contact surfaces are perfectly intact and clean.

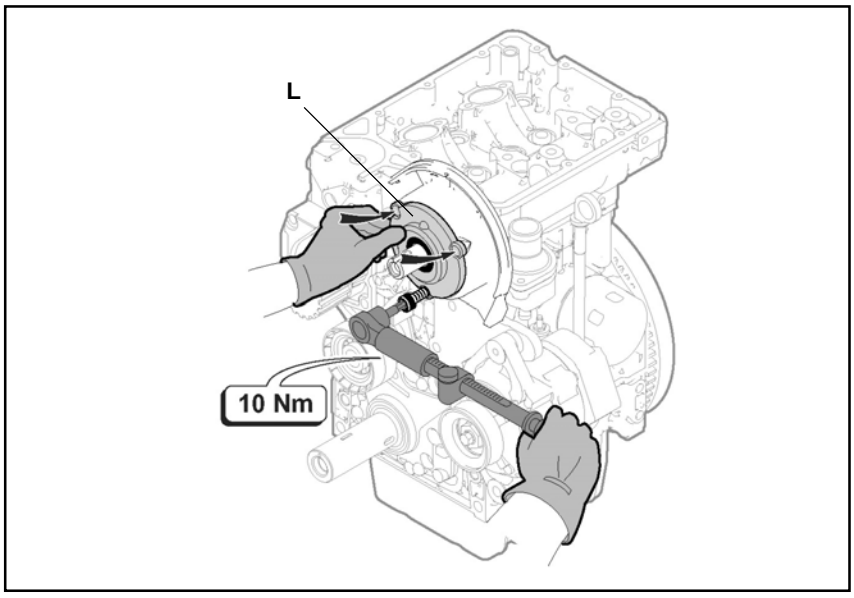
3 - Mount the new O-ring on the cover **(L)**.

4 - Mount the cover **(L)** and fasten the screws without tightening them.

5 - Tighten the screws in an alternating pattern to a final torque of 10 Nm.

Important

Check that the camshaft has no axial clearance.

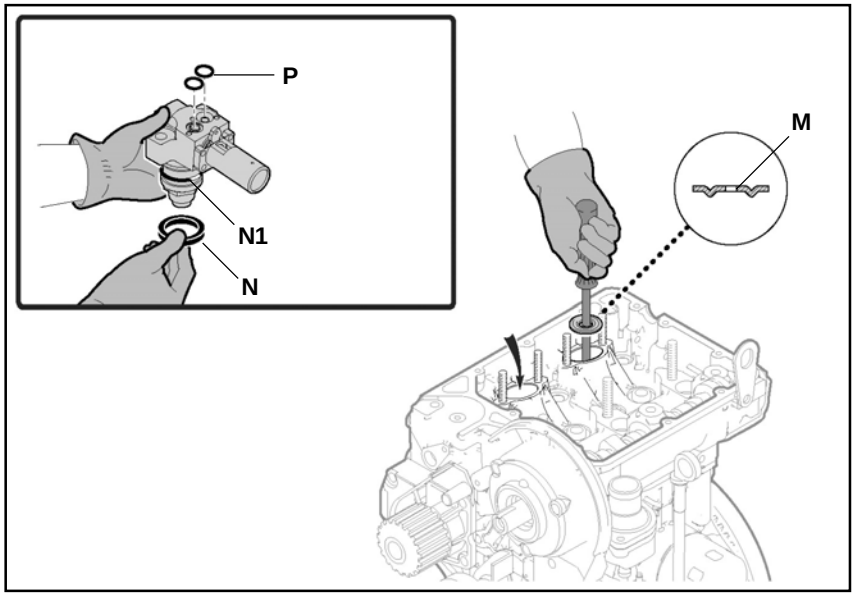


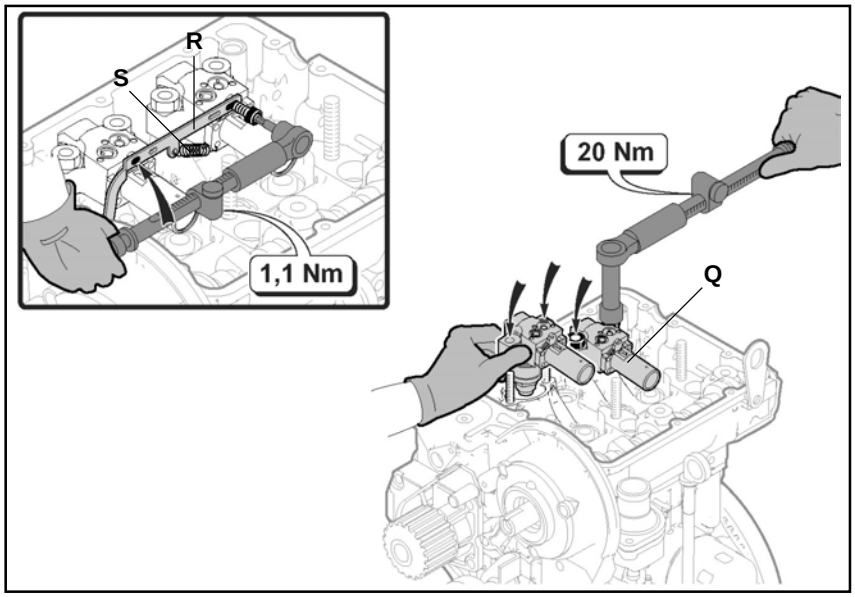
7.6.5 Assembling injection-pumps

Important

- **Check that all components are intact and, if necessary, replace them with original spares.**
- **Before replacing the injectors it is always necessary to replace the flameproof bulkhead, the copper gasket and the oil and diesel O-ring seals.**
- **Always make sure that the injectors are calibrated correctly (see "Calibrating and replacing the injector").**

1 - Insert the flameproof bulkhead **(M)** in the injector seat, with the flat part directed as in the drawing.
2 - Grease the copper gasket **(N)** and the oil O-ring seals **(N1**) copiously.
3 - Install the injector pumps **(Q)** and fasten the nuts without tightening them.
4 - Tighten the nuts to a temporary torque of 10 Nm.
5 - Tighten the nuts to a final torque of 20 Nm.
6 - Hook the connecting rod **(R)** to the adjustment levers and, fasten the injector pumps without fully tightening the screws.
7 - Tighten the screws to a final torque of 1,1 Nm.
8 - Hook the spring **(S**).





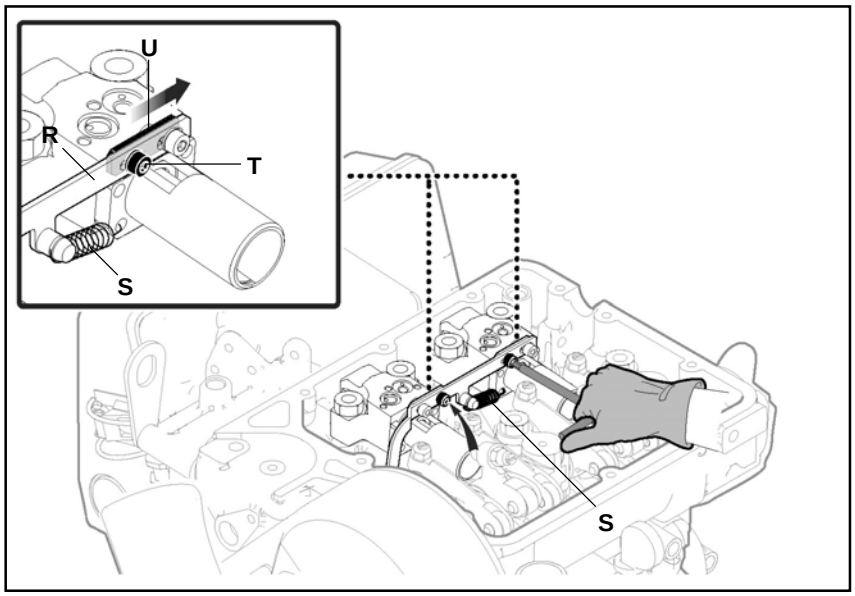
Important

The following procedures must be performed only if pumps have been replaced. Otherwise, go directly to point 13.

Prepare the injector pumps for running the engine, as explained below.

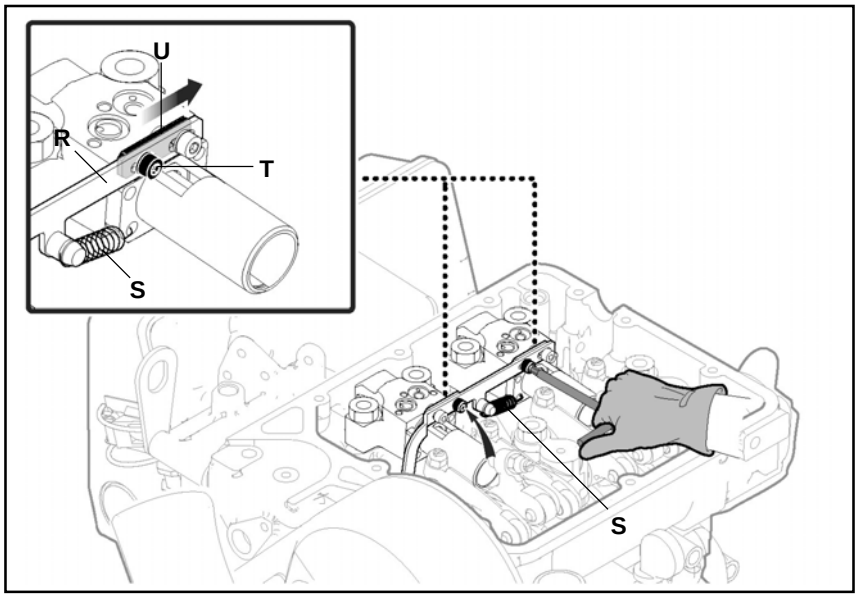
9 - Loosen the screws **(T)** of every injection pump.

10 - Move the plates (**U**) fully towards the flywheel side in order to maximise the injector delivery.



11 - Tighten the screws **(T)** to a torque of 1,1 Nm.

12 - Balance the injector deliveries (see "Balancing injector pump deliveries").



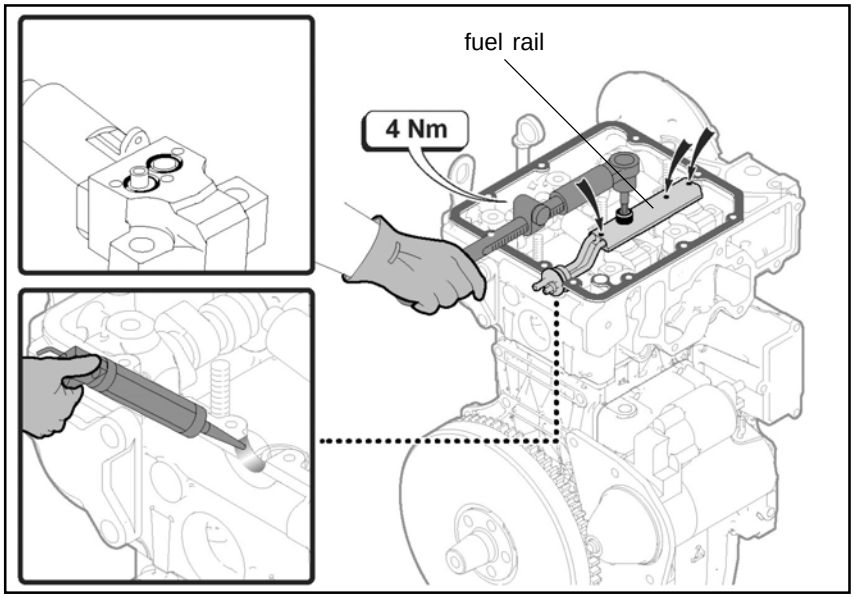
13 - Put the new O-rings on the injector pumps.

14 - Apply sealant to the seat of the fuel rail.

15 - Assemble the fuel rail and fasten the screws without tightening them.

16 - Tighten the screws to a final torque of 4Nm.

17 - Mount the rocker arm cover (see "Assembling the rocker arm cover").

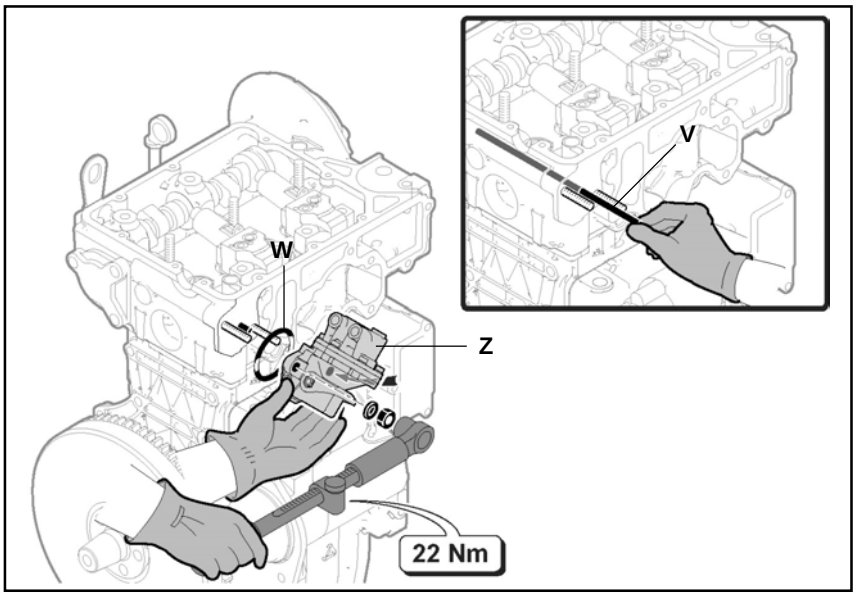


7.6.6 Assembling the mechanical fuel pump

Important

- **Check that the contact surfaces are perfectly clean and intact.**
- **Make sure that the length of the drive rod is between 153,15÷153,25 mm, otherwise replace it.**

1 - Insert the drive rod **(V)**.
2 - Mount a new O-ring **(W)**.
3 - Install the fuel pump **(Z)** and fasten the nuts without tightening them.
4 - Tighten the nuts to a final torque of 22Nm.
5 - Connect the pipes to the pump.



7.6.7 Assembling the rocker arms

Important

Check that the contact surfaces are perfectly clean and intact.

1 - Press down hard on the pump stroke to insert the pin, which facilitates assembly of the drive rods **(B**).

2 - Mount the rocker arm assembly **(A**).

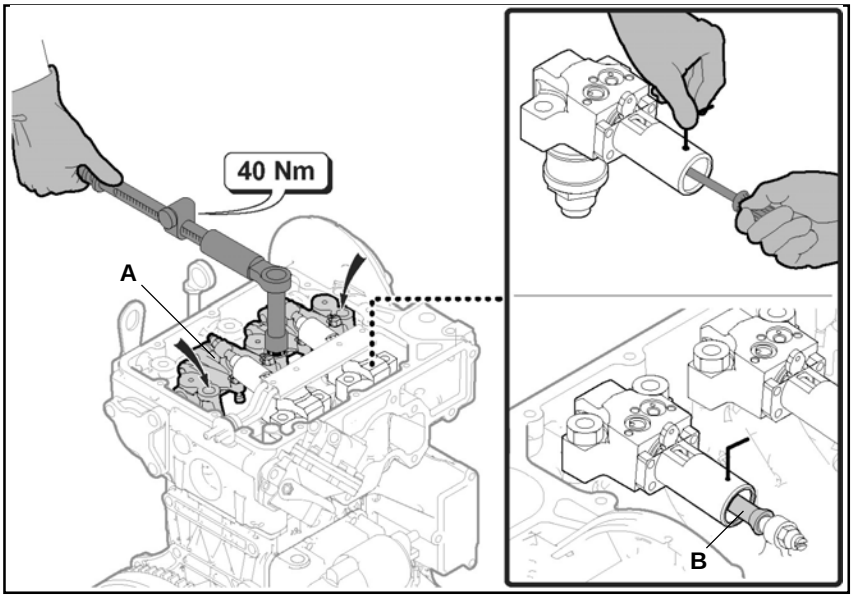
3 - Insert the pump injector activation drive rods **(B)**.

4 - Tighten the nuts by hand.

5 - Tighten the nuts to a temporary torque of 20 Nm.

6 - Tighten the screws in an alternating pattern to a final torque of 40 Nm.

7 - Remove the pins and check that the rocker arms (**B**) have been inserted correctly.



7.6.8 Assembling the rocker arm cover

Important

– Make sure that the rocker arm cover is perfectly clean and dry.
– Check that the contact surfaces are perfectly clean and intact.

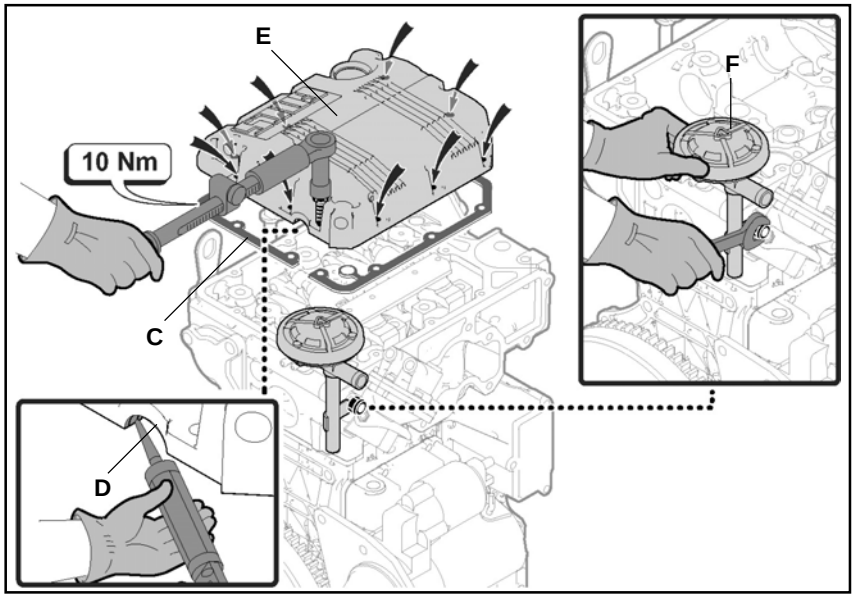
1 - Slip on a new gasket **(C**).

2 - Apply some silicone sealant on the fuel rail seat **(D)**.

3 - Mount the cover **(E)** and fasten the screws without tightening them.

4 - Tighten the screws in a crisscross pattern to a final torque of 10 Nm.

5 - Assemble the negative-pressure vent valve **(F**).



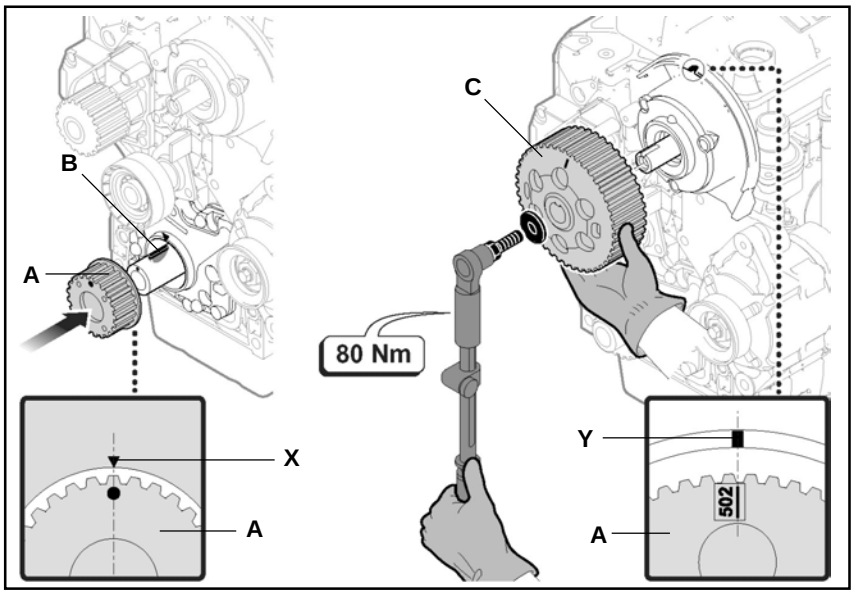
7.7 INSTALLING THE TIMING BELT DRIVE

7.7.1 Assembling the timing belt pulley

1 - Insert the key **(B)** into the crankshaft.

2 - Mount the pulley **(A)**.

3 - Mount the pulley **(C)** and tighten the screw to a torque 80 Nm.

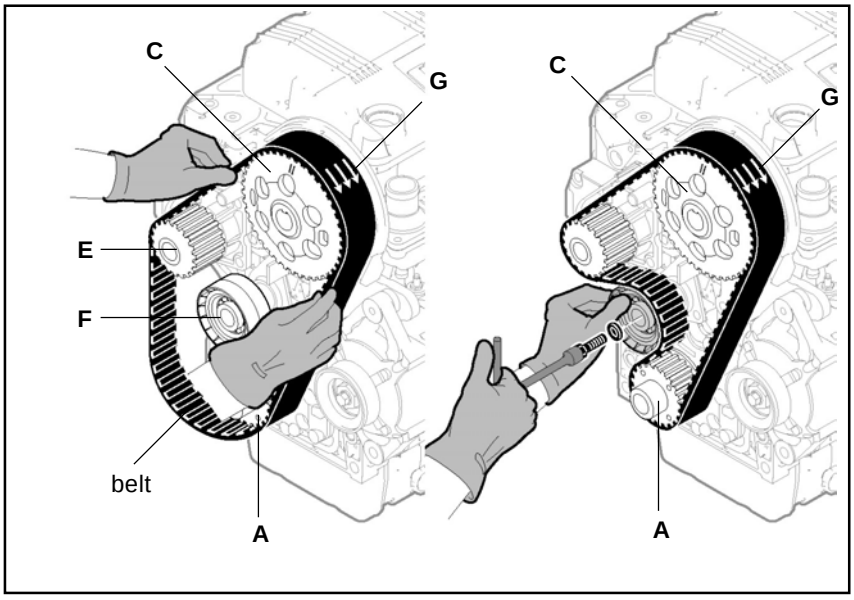


Important

To ensure the correct timing, line up the reference notches on the pulley (A-C) with the respective gear timing notches (X-Y).

7.7.2 Assembling the timing belt

1 - Insert the belt into the pulley **(C)**. Keeping it taut, insert into pulley **(A)**.



Important

- **Keep the reference arrows (G) directed as shown in the diagram.**
- **The timing belt must always be replaced with an original spare part whenever it is removed.**

2 - Keep the belt inserted into the two pulleys and then mount it onto pulley **(E)** and the pulley nut **(F)**.

3 - Tighten the belt using the pulley nut **(F)** and fasten temporarily.

Important

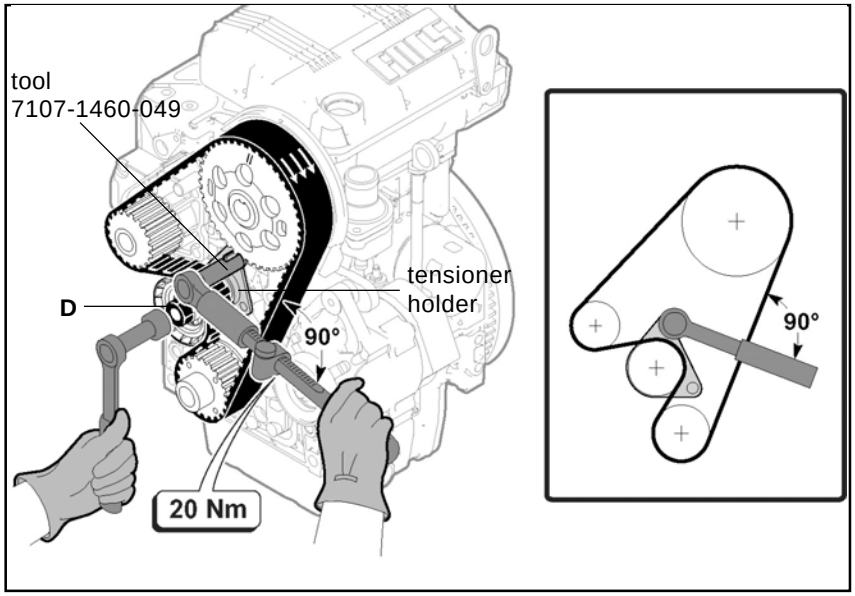
To maintain engine timing while the timing belt is being installed, keep it slotted onto the two pulleys (A-C), which must remain lined up with their notches.

4 - Insert tool "7107-1460-049" in the tensioner holder lever.

5 - Calibrate the torque wrench to 20 Nm and insert it into the tool, with the lever perpendicular to the belt.

6 - Loosen the nut slightly **(D**).

7 - Turn the torque wrench clockwise to tighten the belt to 20 Nm. Once the specified torque is reached (20 Nm), tighten the nut **(D)** temporarily without allowing the belt tension to loose.



8 - Mount the pulley **(G1**).

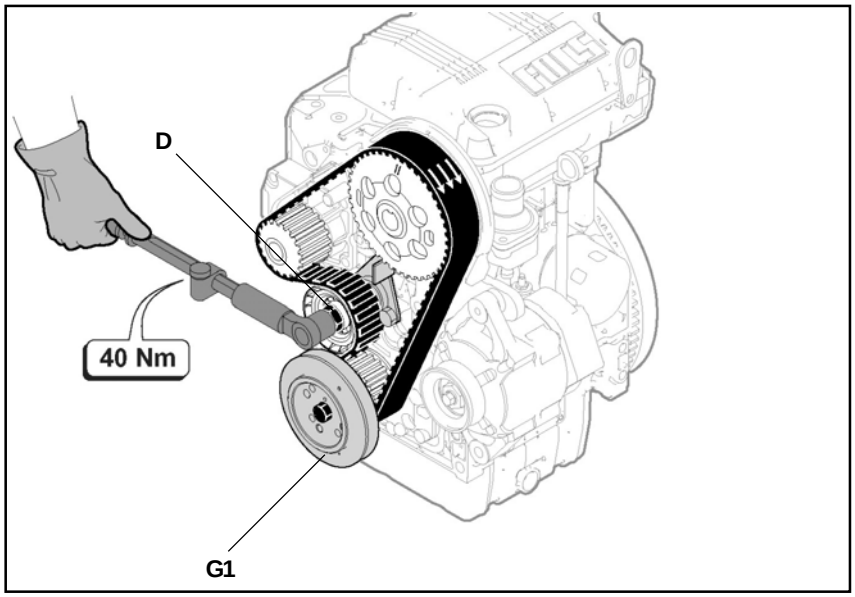
9 - Tighten the nut **(D)** to a final torque of 40Nm.

10 - Rotate the crankshaft a few times to settle and position the belt correctly.

11 - Before doing so, make sure that the pulley notches (crankshaft and camshaft) are lined up with their respective timing notches.

12 - Insert the tool again into the lever on the pulley nut support and repeat all the steps to check belt tension.

13 - Disassemble the pulley **(G1**).



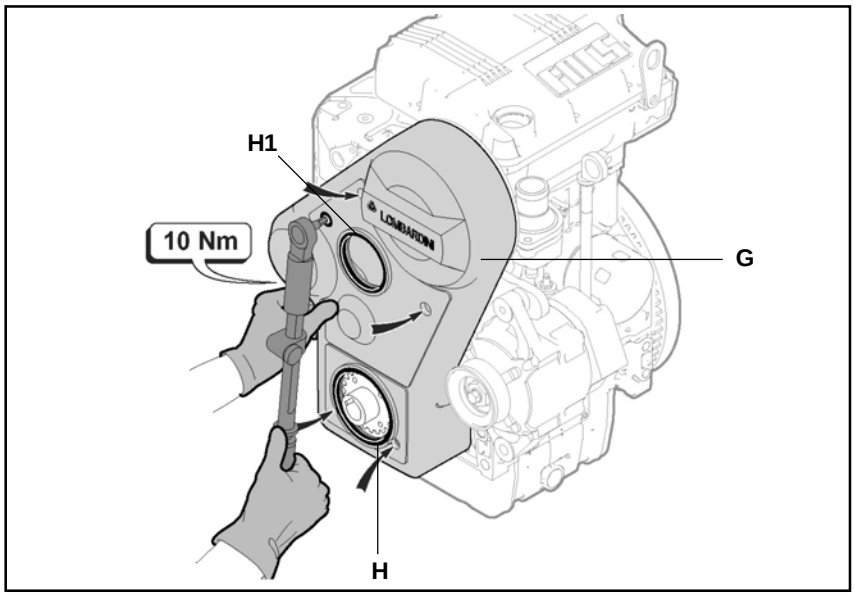
7.7.3 Assembling the belt drive cover

1 - Mount the guard **(G**), without tightening the screws completely.

2 - Tighten the screws in an alternating pattern to a final torque of 10 Nm.

Important

If replacement of the optional dust guard rings (H-H1) and the peripheral sleeve becomes necessary for technical or construction reasons, please request the pre-assembled guard (G) complete with rings and gaskets.



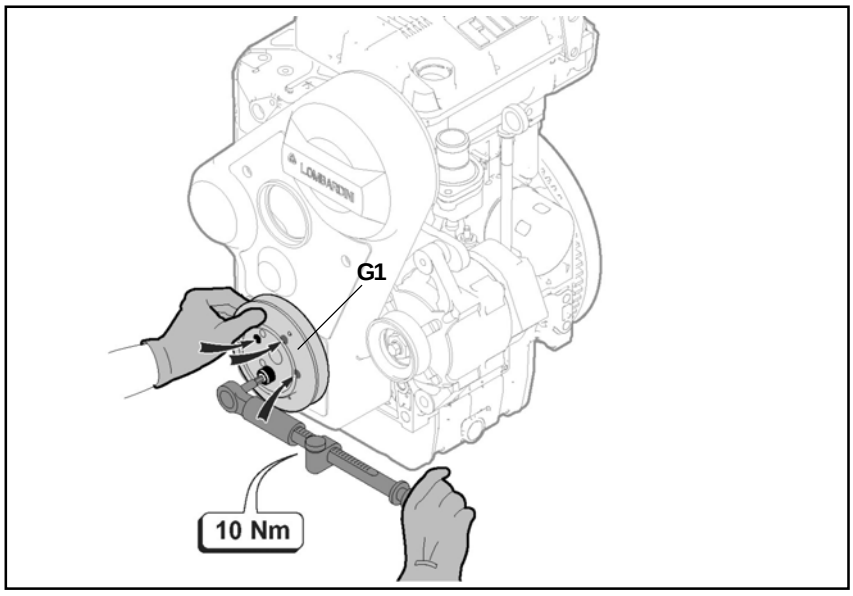
7.8 INSTALLATION OF THE COOLING FAN BELT DRIVE

7.8.1 Assembling the fan belt drive pulleys

1 - Check that all components are intact and, if necessary, replace them with original spares.

2 - Mount the pulley **(G1)** and fasten the screws without tightening them.

3 - Tighten the screws in a crisscross pattern to a final torque of 10 Nm.



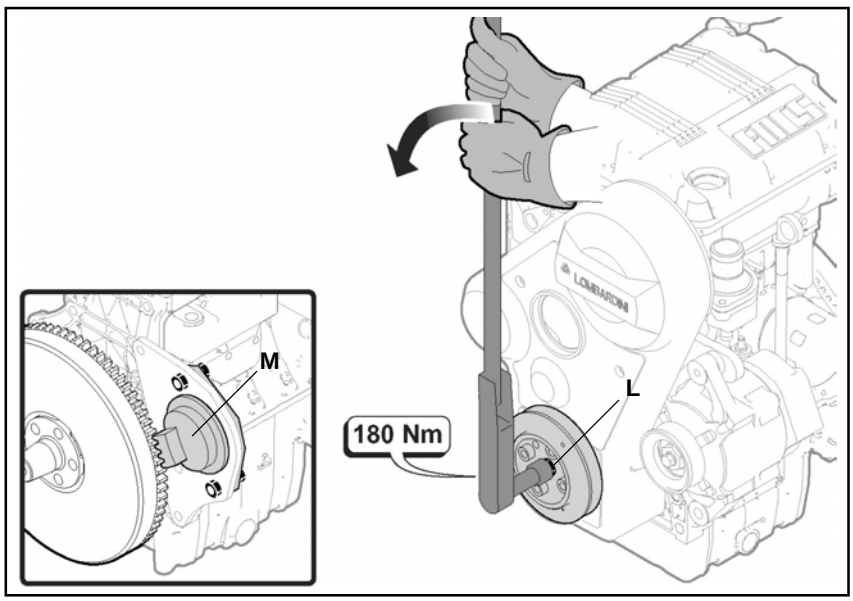
4 - Mount tool “7107-1460-051” to inhibit rotation of the crankshaft.

5 - Apply some anti-seize product to the screw thread **(L)**.

Caution - Warning

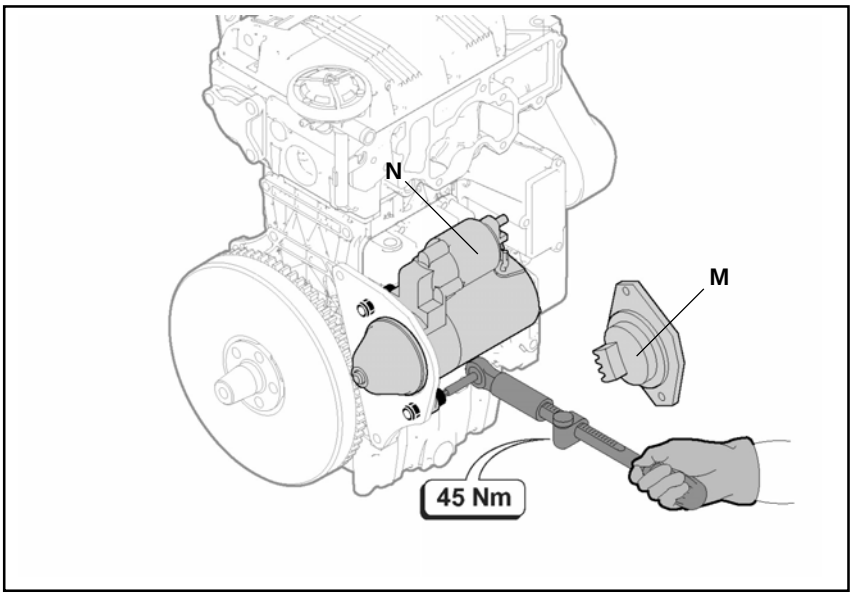
The screw is left-handed. Turn anticlockwise to screw.

6 - Tighten the screw **(L)** to a torque of 180 Nm.



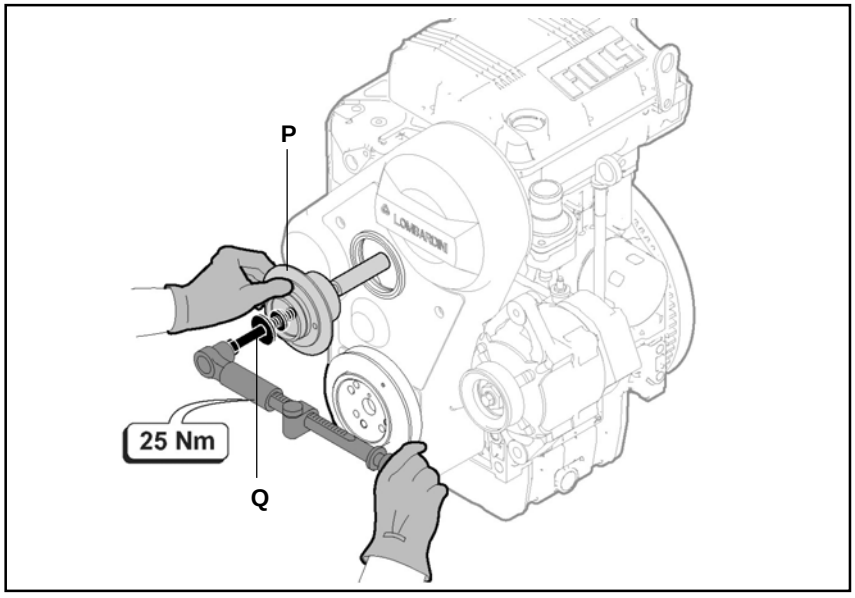
7 - Remove the tool **(M)**.

8 - Install the starter motor **(N)** and tighten the screws to a torque of 45 Nm.



9 - Mount the pulley **(P)**, washers and spacer.

10 - Tighten the screw **(Q)** to a torque of 25 Nm.



7.8.2 Assembling the fan belt drive

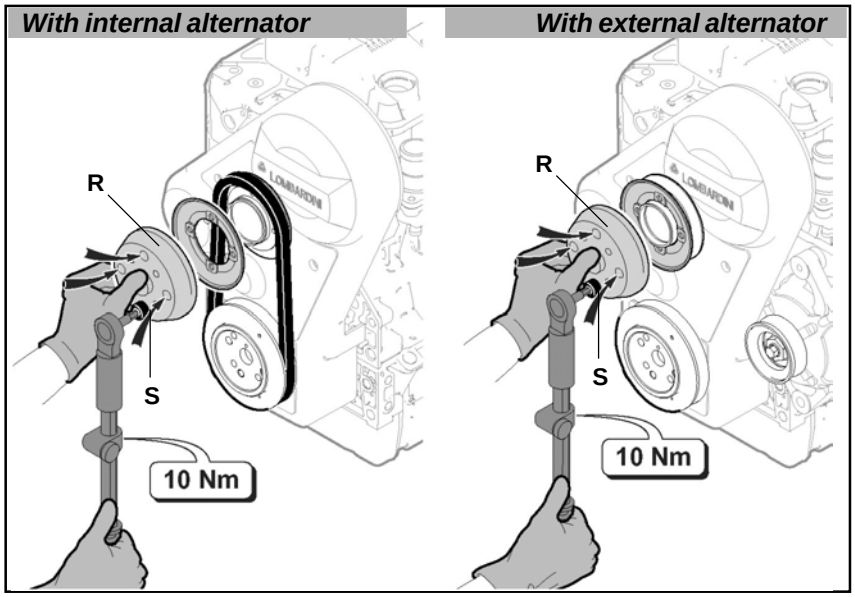
The engine may have an external or internal alternator.

With internal alternator

1 - Install the belt, flange and the pulley hub **(R)**.

2 - Tighten the screws to a torque of 10 Nm.

3 - Carry out belt tension (see “Replacing alternator/fan belt”).



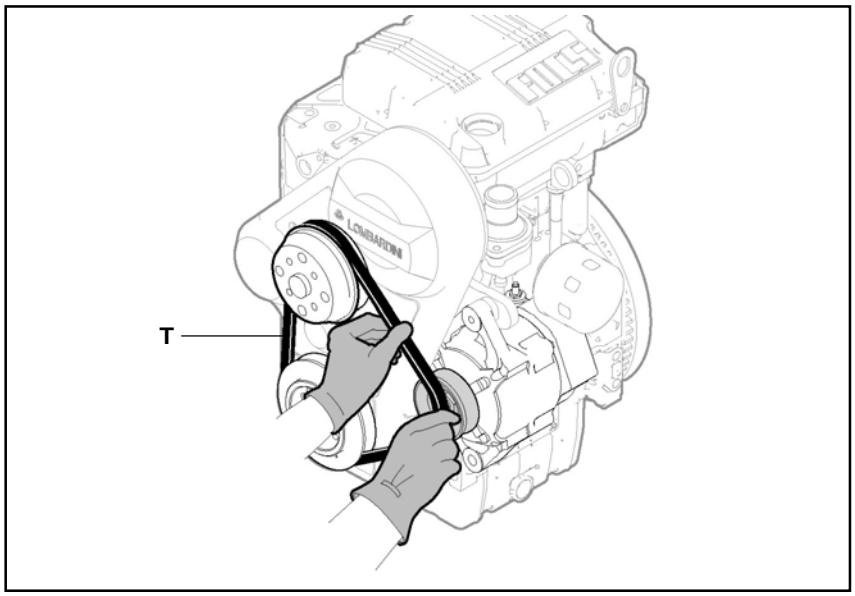
With external alternator

1 - Install the flange and the pulley hub **(R)**.

2 - Tighten the screws to a torque of 10 Nm.

3 - Install the belt **(T)**.

4 - Tighten the belt **(T)** (see “Replacing the alternator – fan belt”).

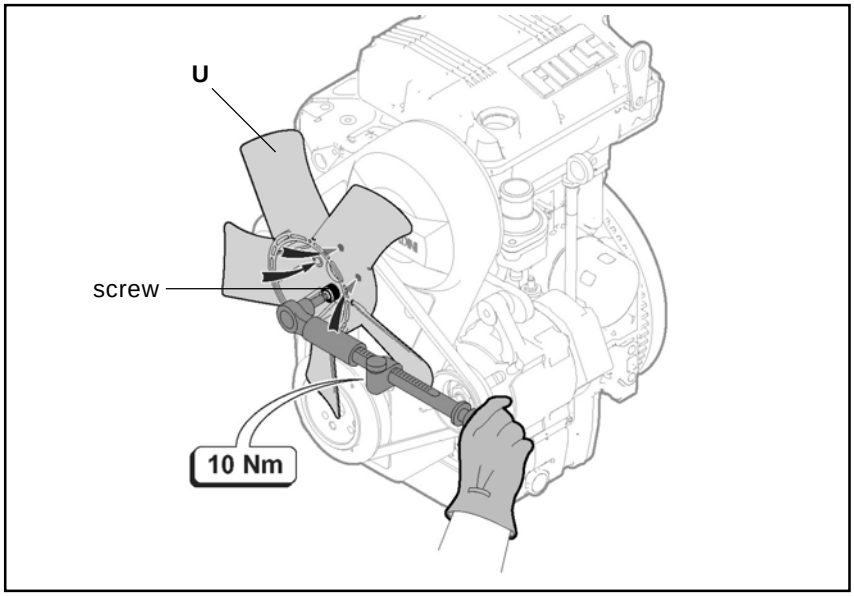


7.8.3 Assembling the cooling fan

1 - Check that the fan is intact and, if necessary, replace it with an original spare.

2 - Install the cooling fan **(U**).

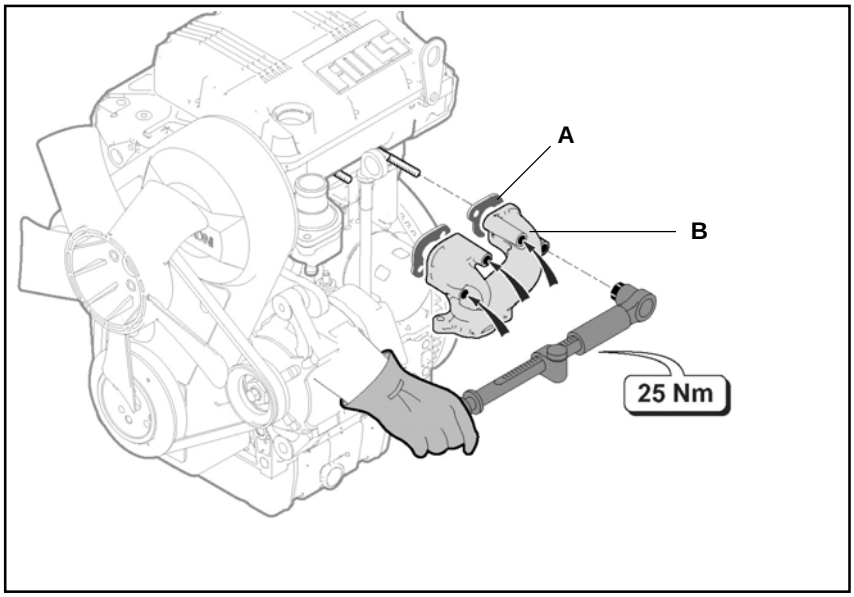
3 - Tighten the screws to a torque of 10 Nm.



7.9 INSTALLING INTAKE AND EXHAUST MANIFOLDS

7.9.1 Assembling exhaust manifold

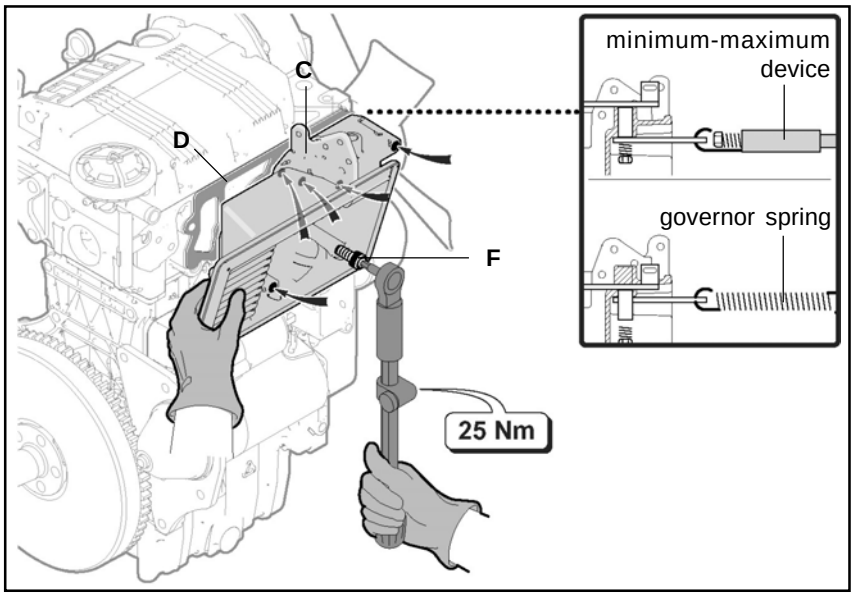
1 - Make sure that the manifold ducts are clean and intact.
2 - Check that the contact surfaces are perfectly clean and intact.
3 - Eliminate any blockages in the ducts.
4 - Put on the new gaskets **(A**).
5 - Mount the manifold **(B)** without tightening the nuts completely.
6 - Tighten the screws in an alternating pattern to a final torque of 25 Nm.



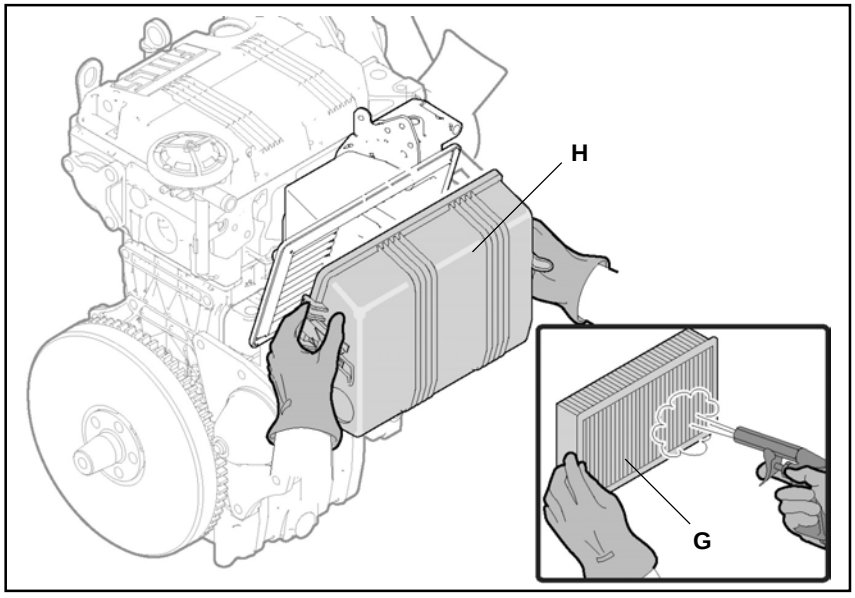
7.9.2 Assembling the intake manifold

"Panel dry air" filter

1 - Check that the contact surfaces are perfectly clean and intact.
2 - Eliminate any blockages in the ducts.
3 - Slip on a new gasket **(D)**.
4 - Bring the manifold (**C**) up to the cylinder head and hook on the minimum-maximum device or the governor spring.
5 - Install the manifold **(C)** without tightening the screws **(F)** completely.
6 - Tighten the screws in an alternating pattern to a final torque of 25 Nm.



7 - Clean the cover **(H)** witha a jet of air.
8 - Check the state of the filter cartridge **(G)**. If necessary, remove the cartridge, knock it repeatedly against a flat surface to eliminate dirt and clean with a jet of air.
9 - Return the cleaned filter cartridge or replace it with an original spare.



Caution - Warning

Do not use liquids to clean the filter cartridge.

10 - Replace the cover **(H)** and re-hook it carefully into place.

Filtro "a cartuccia"

1 - Check that the contact surfaces are perfectly clean and intact.

2 - Eliminate any blockages in the ducts.

3 - Slip on a new gasket **(L)**.

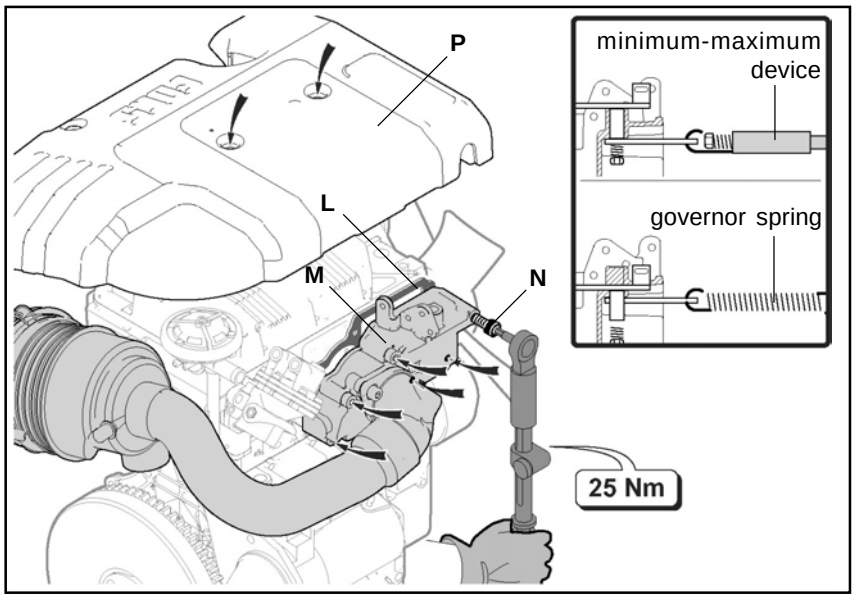
4 - Bring the manifold **(M)** up to the cylinder head and hook on the minimum-maximum device.

5 - Install the manifold **(M)** without tightening the screws **(N)** completely.

6 - Tighten the screws in an alternating pattern to a final torque of 25Nm.

7 - Check the state of the filter cartridge. If necessary, remove the cartridge and clean with a jet of air.

8 - Return the cleaned filter cartridge or replace it with an original spare.



Caution - Warning

Do not use liquids to clean the filter cartridge.

9 - Replace the filter housing.
10 - Mount the cover **(P)**.

Notes :

8.1 RACCOMMENDATIONS FOR REPLACING PARTS

– This chapter describes the procedures for replacing a number of components and/or assemblies which are not recommended for repairs.

– Some of these operations are also contained in the user's operation and maintenance manual.

– Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.

– Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.

– All operations, except where expressly stated otherwise, must be carried out when the engine is not running and has cooled sufficiently to avoid the risk of burns.

Important

To locate specific topics, the reader should refer to the index.

8.2 REPLACING THE ALTERNATOR - FAN BELT

Important

Replacement may be carried out with the engine installed on the machine.

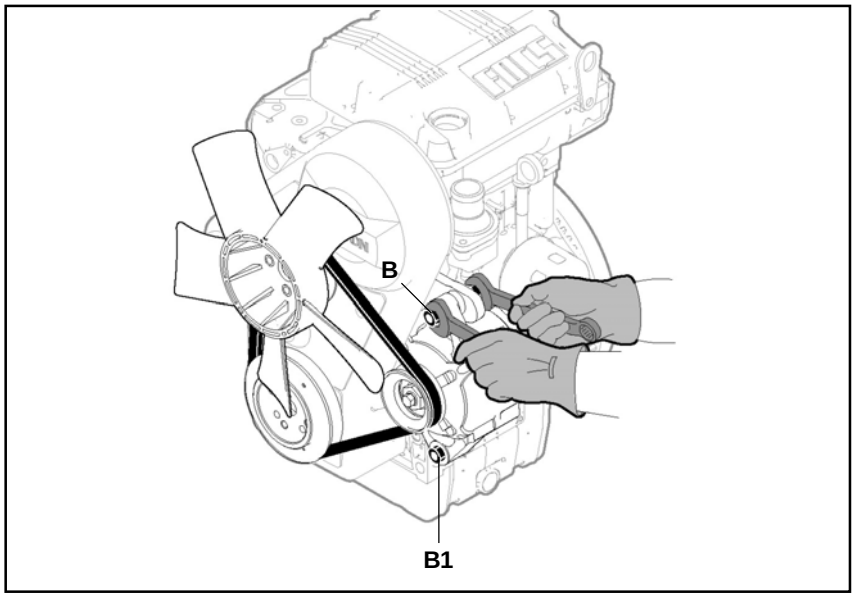
The engine may have an external or internal alternator.

With external alternator

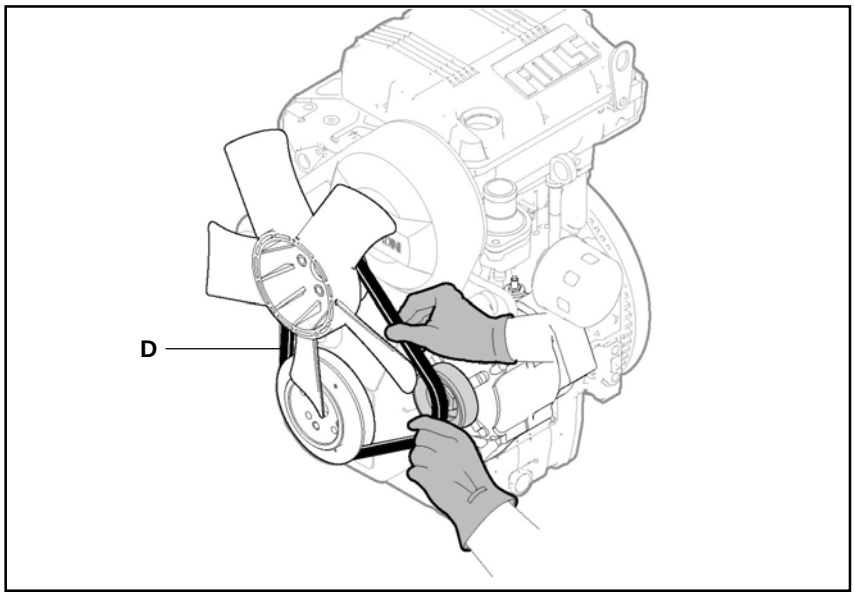
1 - Switch off the engine and leave to cool.

2 - Loosen the nuts **(B - B1**).

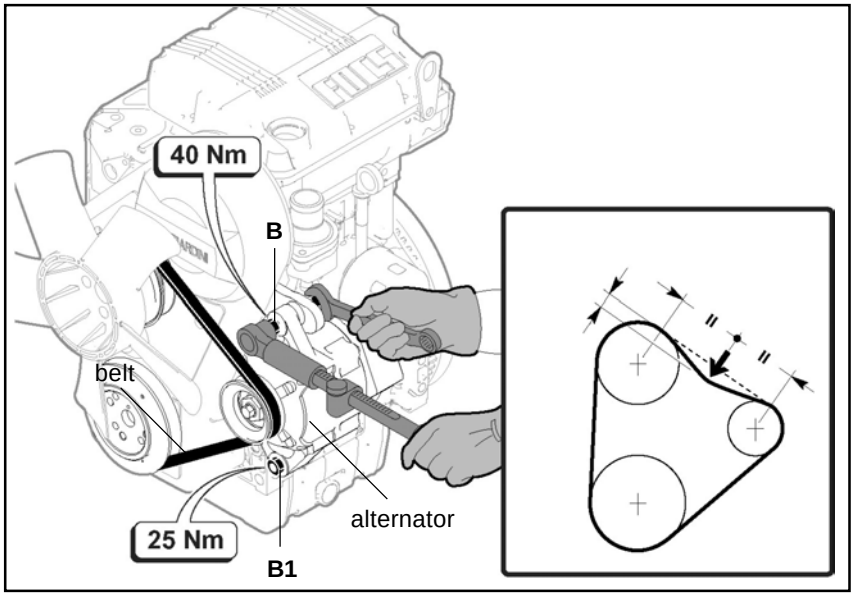
3 - Loosen the belt by adjusting the alternator manually and tighten the nut **(B1**).



4 - Slip off the belt **(D)** and replace it with an original spare.



5 - Adjust the alternator manually while at the same time tightening the screw to regulate belt tension.



Important

Use the method shown in the diagram to check belt tension. The resultant (R) must be 10÷15 mm.

6 - Tighten the nuts **(B -B1)** to a final torque of 40Nm and 25Nm respectively.

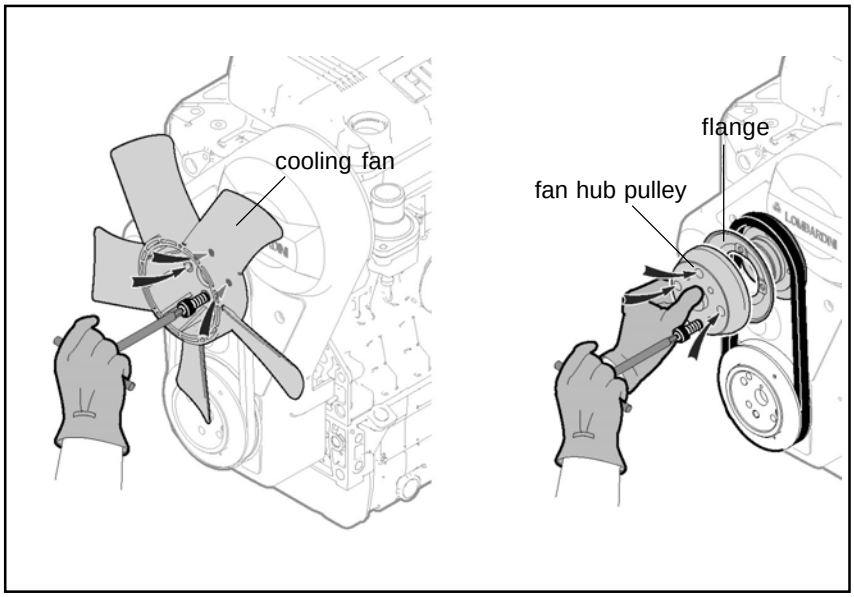
With internal alternator

1 - Switch off the engine and leave to cool.

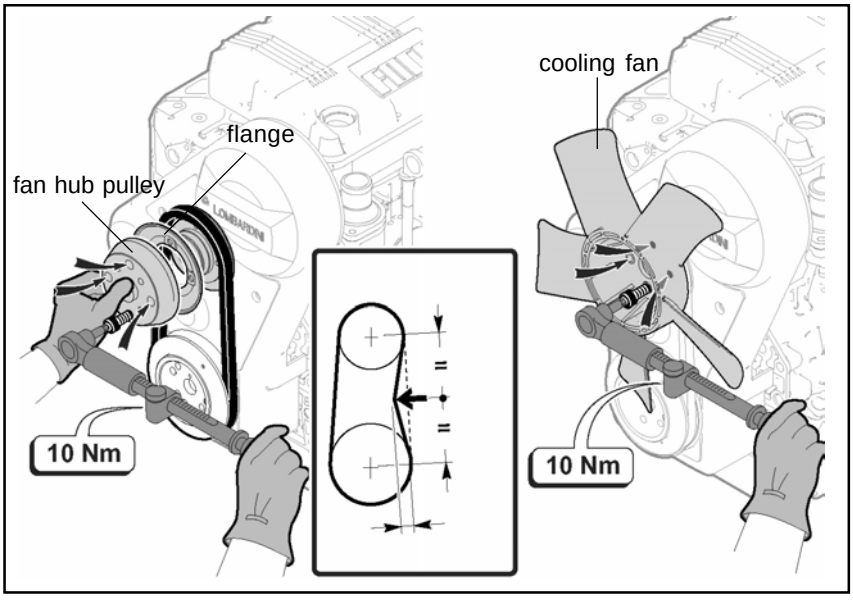
2 - Remove the cooling fan.

3 - Remove the hub and flange.

4 - Slip off the belt and replace it with an original spare.



5 - Install the flange and pulley hub.
6 - Manually rotate the fan to make sure the belt is fitted correctly.
7 - Tighten the screws to a torque of 10 Nm.
8 - Regolare la tensione della cinghia.

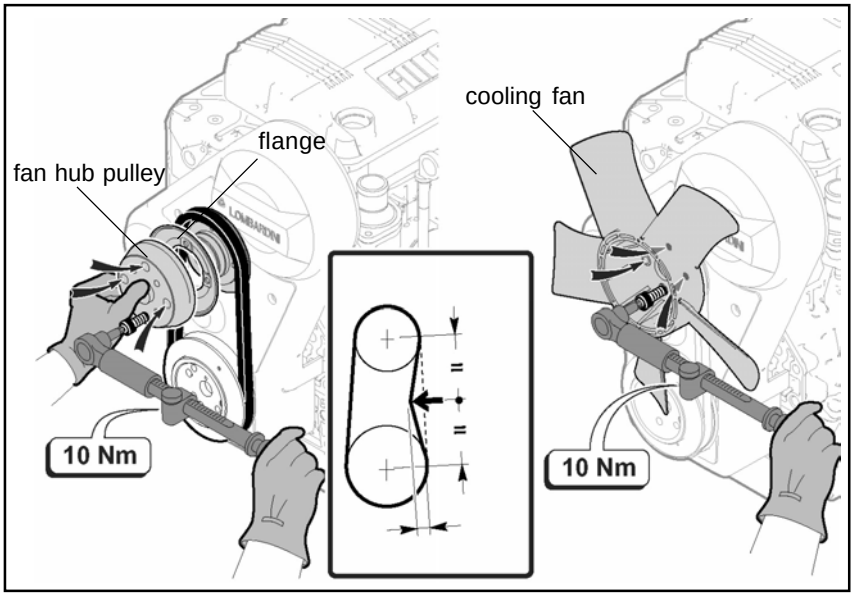


Important

– To check the belt tension, follow the procedure explained in the figure. The resultant (R) must be 10÷15 mm.
– If the belt is too tense, insert a spacer between the flange and the pulley, or remove a spacer if it is too slack.

9 - Install the cooling fan.

10 - Tighten the screws to a torque of 10 Nm.



8.3 REPLACING THE TIMING BELT

Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.

2 - Disassemble the cooling fan belt drive (see “Removing the cooling fan belt drive”).

3 - Disassemble the timing belt drive (see “Removing the timing belt drive”).

4 - Replace the timing belt with an original spare (see “Assembling the timing belt drive”).

5 - Check the timing belt rating (see “Checking timing belt rating”).

6 - Mount the belt drive cover (see “Assembling the belt drive cover”).

7 - Replace the cooling fan belt drive (see “Installation of the cooling fan belt drive”).

8.4 REPLACING THE OIL FILTER

Important

Replacement may be carried out with the engine installed on the machine.

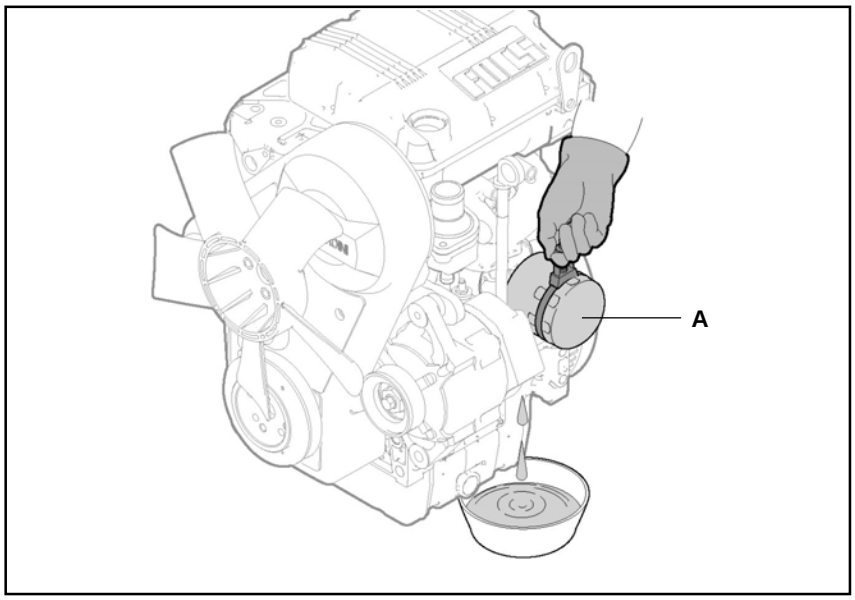
1 - Switch off the engine and leave to cool.

2 - Prepare a receptacle to catch leaks.

3 - Remove the filter **(A)** using the special tool.

4 - Lubricate the new filter seal with engine oil.

5 - Install and tighten the filter manually.



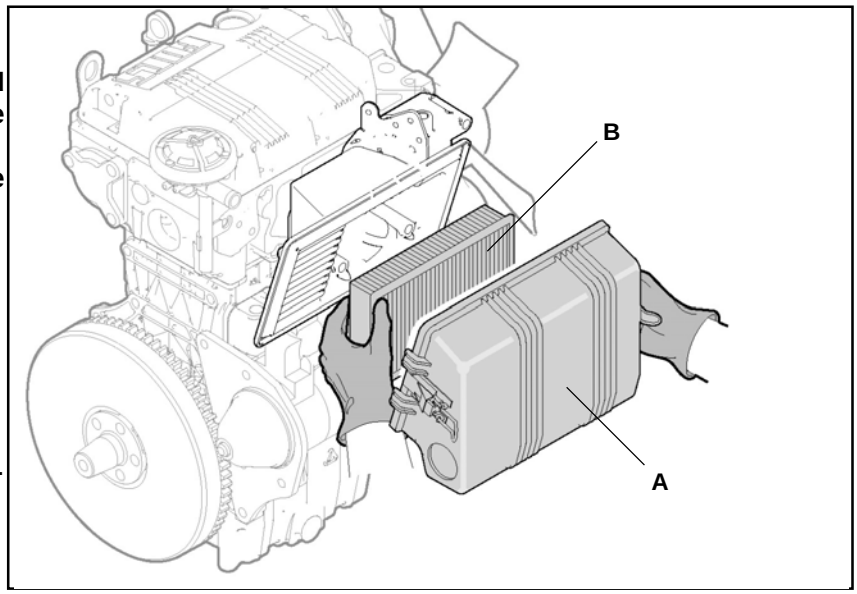
Important

Polluting substances should be disposed of properly, in full compliance with the law.

8.5 REPLACING THE AIR FILTER

Important

- **Polluting substances should be disposed of properly, in full compliance with the law.**
- **Replacement may be carried out with the engine installed on the machine.**



Filtro "a pannello"

1 - Switch off the engine and leave to cool.

2 - Remove the cover **(A**).

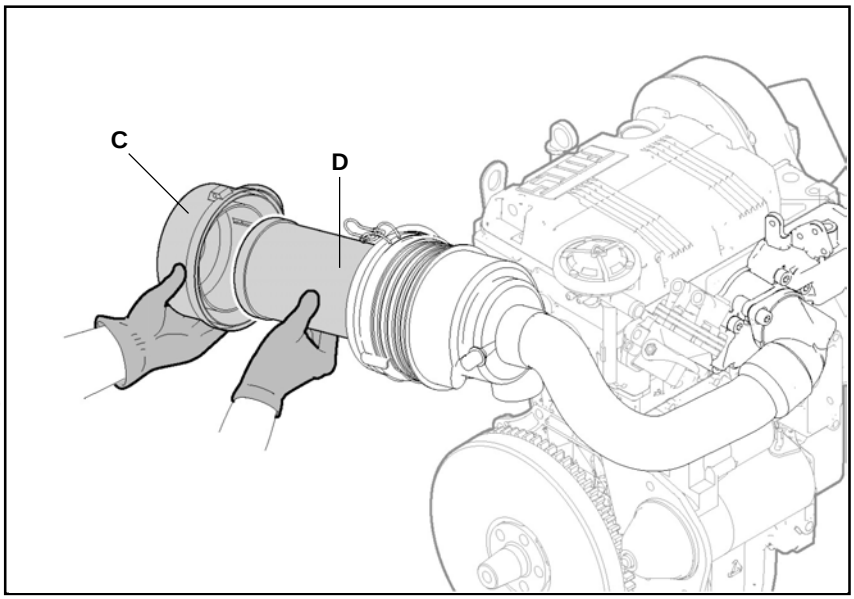
3 - Extract the cover that is to be replaced **(B**).

4 - Clean the cover with a jet of air.

5 - Replace the cartridge with an original spare.

6 - Mount the cover and hook it carefully into place.

Filtro "a cartuccia"



1 - Switch off the engine and leave to cool.

2 - Remove the cover **(C**).

3 - Extract the cover that is to be replaced **(D**).

4 - Clean the cover with a jet of air.

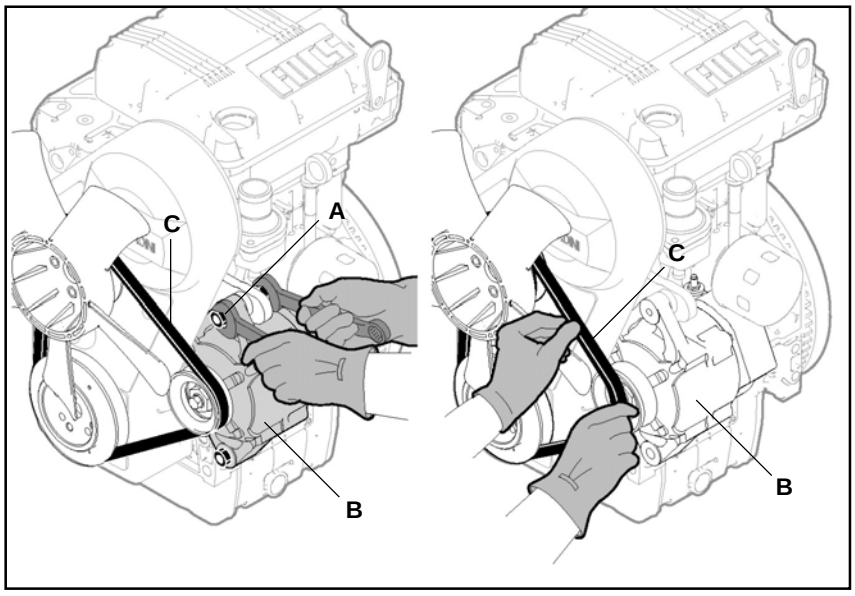
5 - Replace the cartridge with an original spare.

6 - Mount the cover and hook it carefully into place.

8.6 REPLACING THE ALTERNATOR

Caution - Warning

Replacement may be carried out with the engine installed on the machine.



1 - Switch off the engine and leave to cool.

2 - Disconnect the battery.

3 - Disconnect the electrical connectors.

4 - Loosen the nut **(A)**.

5 - Loosen the belt **(C)** by adjusting the alternator **(B)** manually.

6 - Slip the belt **(C)** off the alternator pulley.

7 - Remove the alternator and replace it with a new one.

8 - Insert the belt into the alternator pulley.

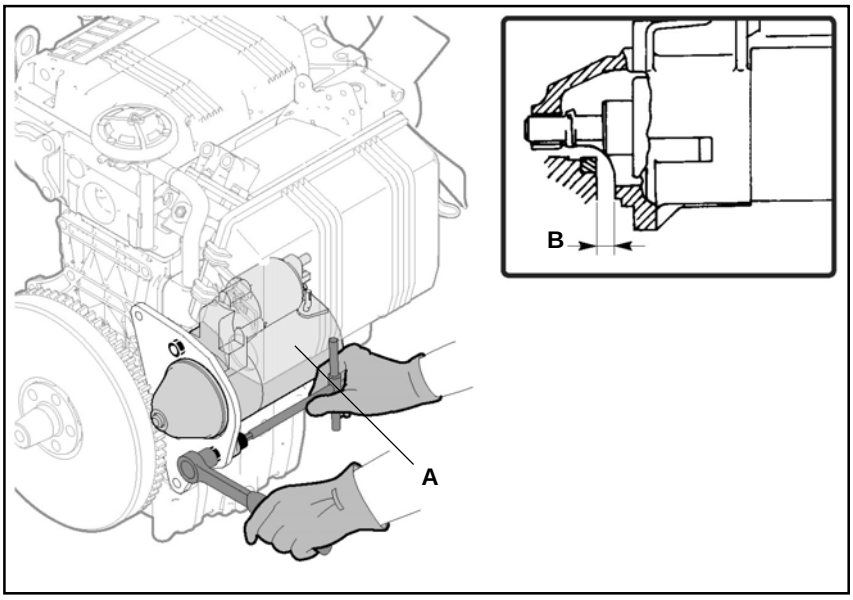
9 - Regulate belt **(C)** tension (see “Replacing alternator – fan belt”).

10 - Reconnect the electrical connectors.

8.7 REPLACING THE STARTER MOTOR

Caution - Warning

Replacement may be carried out with the engine installed on the machine.



1 - Switch off the engine and leave to cool.

2 - Disconnect the electrical connectors.

3 - Remove the starter motor.

Important

If in order to take care of the problem it is necessary to remove the motor, please refer to an authorised BOSCH service centre.

4 - Install the starter motor **(A)** and tighten the screws.

5 - Tighten the screws to a final torque of 40 Nm.

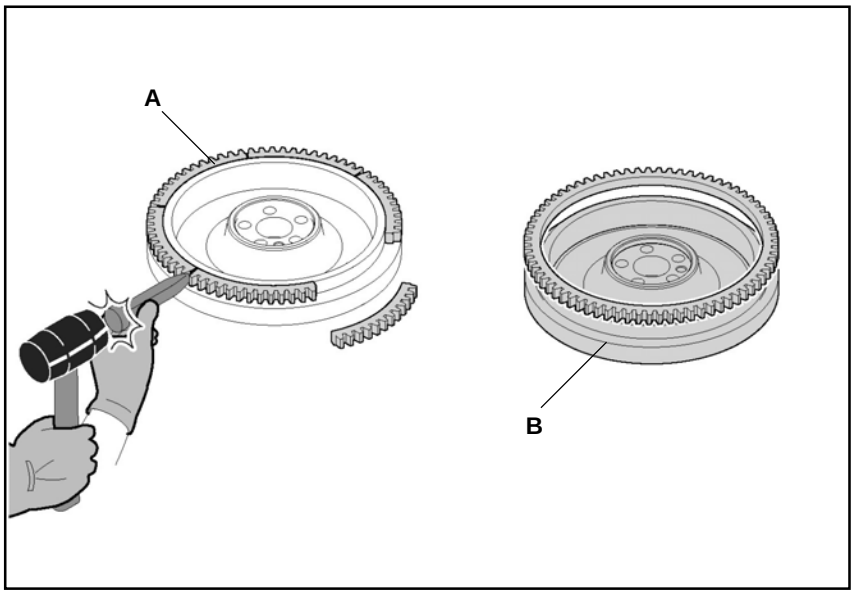
6 - Make sure that the distance **(B)** is between 17,5÷19,5 mm.

7 - Reconnect the electrical connectors.

8.8 REPLACING THE FLYWHEEL RING GEAR

In order to replace the ring gear, it is necessary to disassemble the flywheel.
See “Disassembling the flywheel” for the correct procedure.

1 - Cut the ring gear **(A)** in several places using a chisel and remove it.



Important

Remove any debris and carefully clean the ring gear.

2 - Heat the new ring gear uniformly and keep it at a temperature of 300°C for15÷20 minuti.

Caution - Warning

Risk of burning: be careful of hot surfaces.

3 - Insert the ring gear into its seat and place it carefully on the rim of the flywheel **(B)**.

4 - Leave to the ring gear to cool gently before reassembling the flywheel.

8.9 REPLACING THE COOLANT THERMOSTAT

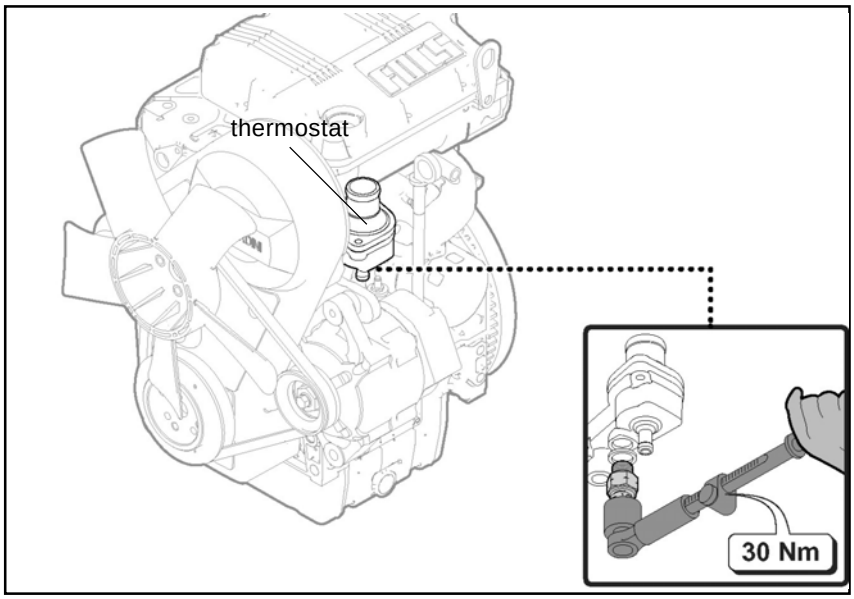
Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.

2 - Disconnect the electrical connectors.

3 - Remove the thermostat.



Important

The screw is left-handed, turn clockwise to unscrew.

4 - Install the new thermostat.

5 - Tighten the thermostat to a torque of 30 Nm.

Important

The screw is left-handed, turn anti-clockwise to tighten.

6 - Reconnect the electrical connectors.

8.10 REPLACING THE COOLANT PUMP

Important

Replacement may be carried out with the engine installed on the machine.

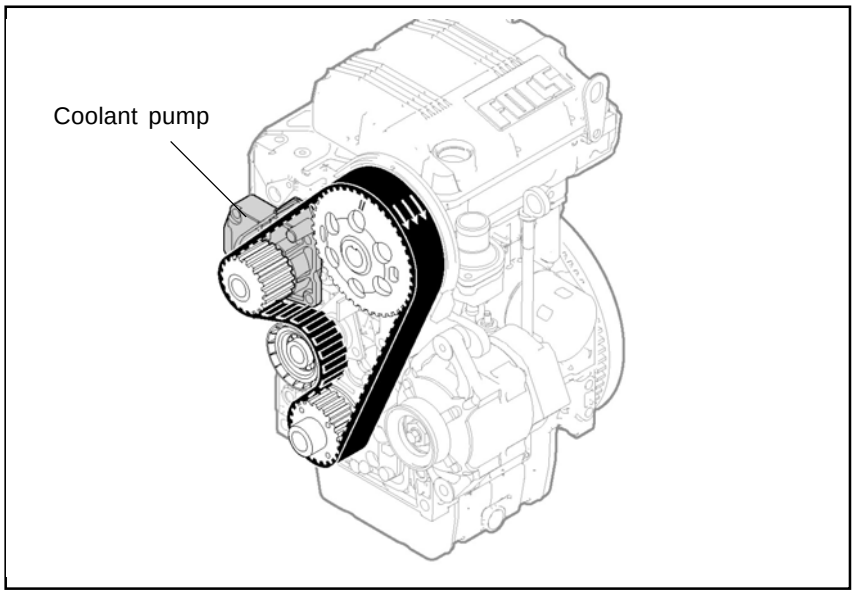
1 - Switch off the engine and leave to cool.

2 - Disassemble the cooling fan (see "Removing the cooling fan belt drive").

3 - Disassemble the timing belt drive (see "Removing the timing belt drive").

4 - Disassemble the coolant pump.

5 - Install a new pump and tighten the screws to a torque of 20 Nm.



Important

Following a failure, the coolant pump cannot be repaired and must be replaced with an original spare.

8.11 REPLACING THE THERMOSTATIC VALVE

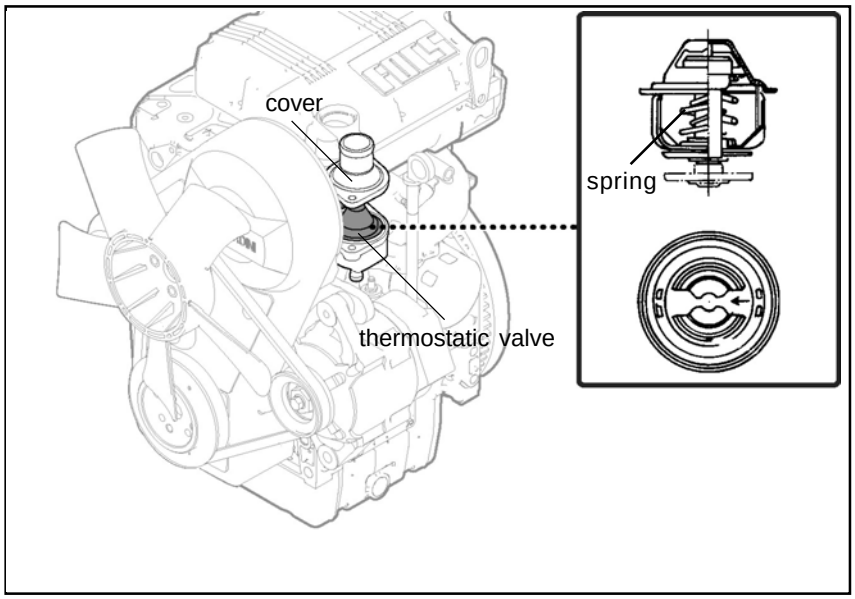
Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.
2 - Remove the cover.
3 - Remove the valve and make sure it is working properly.

Important

The valve must be heated in order to check weather it is functioning correctly.
- **Dip the thermostatic valve in a metal container of water.**
- **Use a thermometer with a full scale of 150°C to monitor the temperature of the water in the container.**
- **Heat the water and, using the thermometer, make sure that the temperature at which the valve begins to open is between 78 and 82°C.**
- **If the thermostatic valve opens at a different temperature, it must be replaced.**
- **Maintaining the conditions described above, heat the water to 94°C and check whether or not the valve is completely open at this temperature, i.e. that it has lifted to 7mm.**



- **Check whether the valve is completely shut once it has cooled down.**

If the length does not correspond to the value shown, replace the valve spring with an original spare.

4 - Mount the cover and fasten the screws.

8.12 REPLACING THE NEGATIVE-PRESSURE VENT VALVE

Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.

2 - Loosen nut **(A**).

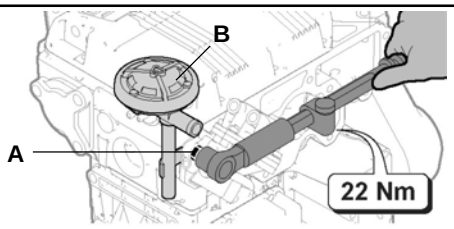
3 - Loosen the clamps and disconnect the pipes.

4 - Take off the negative-pressure vent valve **(B)**.

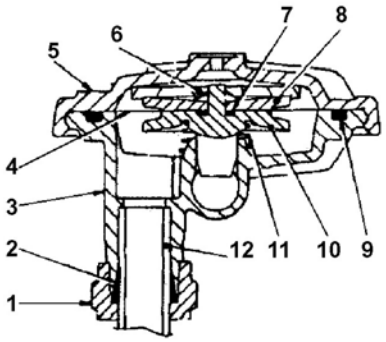
5 - Install the negative-pressure vent valve.

6 - Tighten the nut to a final torque of 22Nm.

7 - Connect the pipe to the coupling.



Caption
1) Nut
2) Bushing
3) Valve body
4) Diaphram
5) Bottom plate
6) Quicklock ring
7) O-ring
8) Collar
9) O-ring
10) Seal collar
11) Spring
12) Gas vent pipe



8.13 REPLACING THE PREHEATING GLOW PLUGS

Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.

2 - Remove the intake manifold (see "Disassembling the intake manifold").

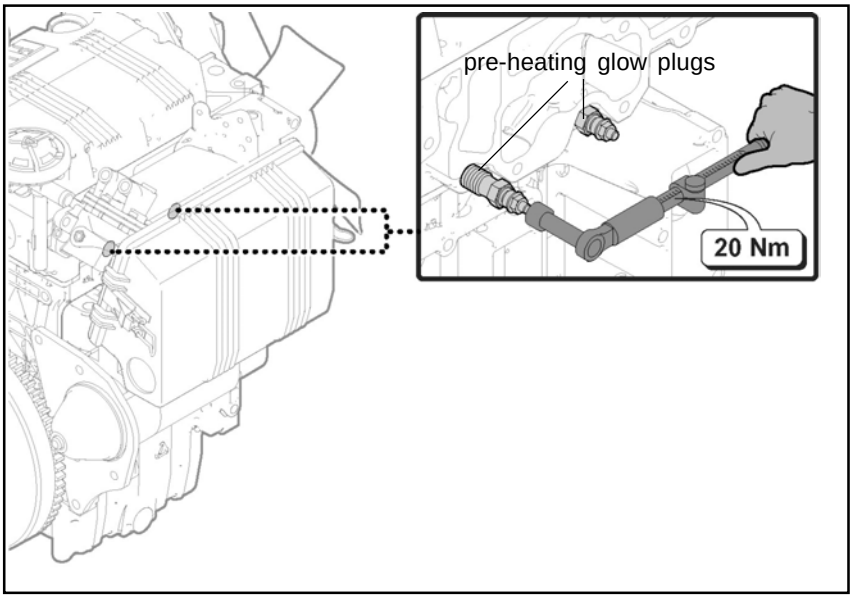
3 - Disconnect the electric cable.

4 - Disconnect the preheating glow plugs.

5 - Install the new preheating glow plugs and tighten the screws to a torque of 20 Nm.

6 - Reconnect the electric cable.

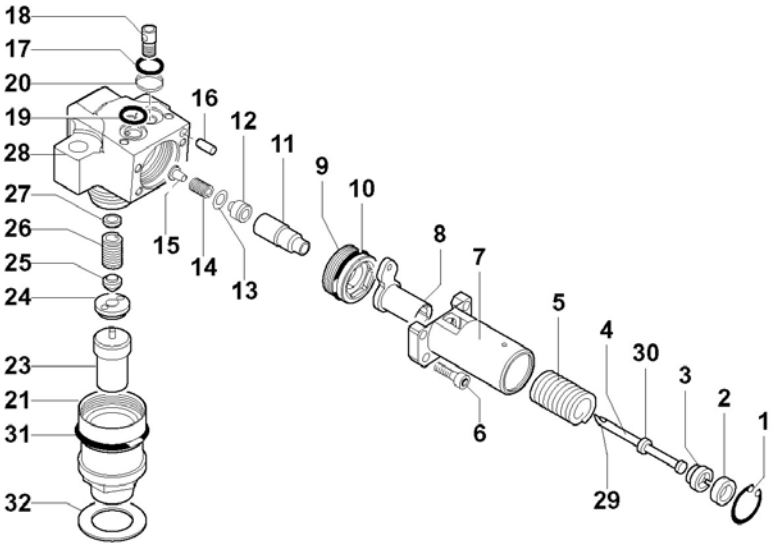
7 - Mount the intake manifold (see "Assembling the intake manifold").



8.14 REPLACING INJECTOR PUMP PARTS

Exploded diagram of the injector pump
The figure shows the injector pump parts.

Caption
1) Tension washer
2) Tappet
3) Stop collar
4) Plunger
5) Spring
6) Screw
7) Support
8) Lever
9) Ring nut
10) O-ring
11) Barrel
12) Delivery valve
13) Gland
14) Spring
15) Filler
16) Pin
17) O-ring
18) Non-return valve
19) O-ring
20) Metal gland (new type)
21) Ring nut
23) Nozzle
24) Spacer
25) Preassure rod
26) Spring
27) Setting adjusting shim
28) Injector case
29) Control blade
30) Plunger guide
31) O-ring
32) Copper gland



8.14.1 Pumping element replacement

1 - Press down hard on the pump collar to fit the pin **(A**).

2 - Disassemble the lock ring **(1**).

3 - Press down hard on the pump collar to remove the pin **(A)**.

4 - Remove the parts **(2-3-4-5**).

5 - Loosen the screws **(6**).

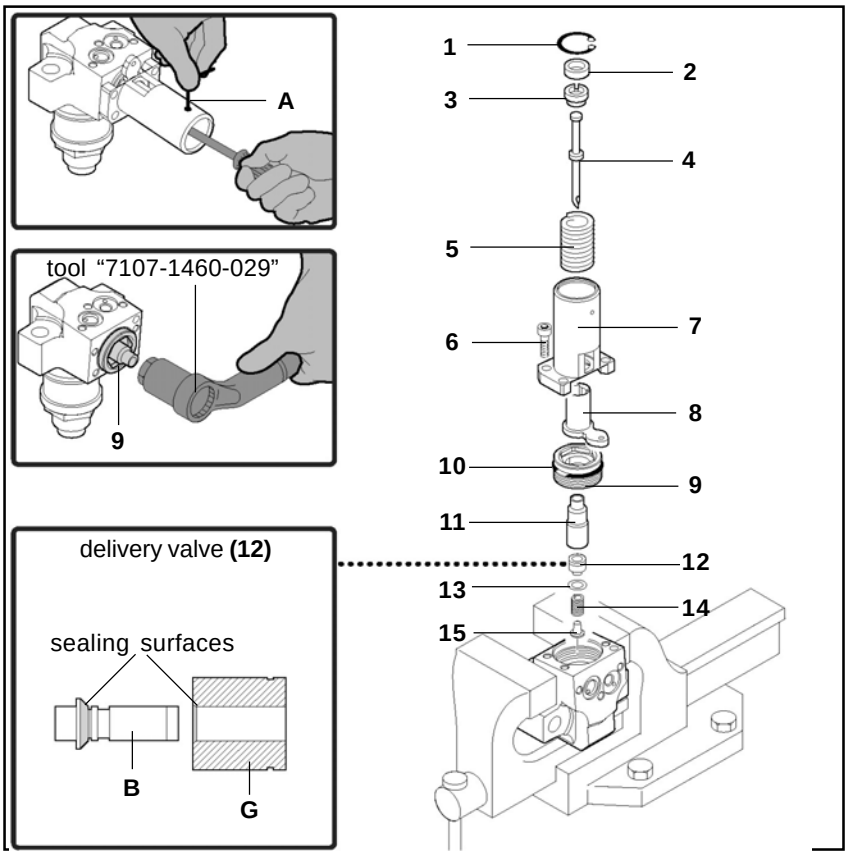
6 - Disassemble the support **(7)** and the lever **(8**).

7 - Insert tool "7107-1460-029" and disassemble the ring nut **(9**).

Important

Rotate in an alternating way the ring nut during disassembling to avoid damaging the O-ring (10).

8 - Extract the barrel **(11**), the valve **(12)** as well as the parts **(13-14-15**).



9 - Check the good seal of the delivery valve **(12)** as well as of the pumping element (parts **4-11**). If necessary, replace them with original spare parts.

10 - Assemble all parts **(15-14-13**).

11 - Assemble the delivery valve **(12**).

Important

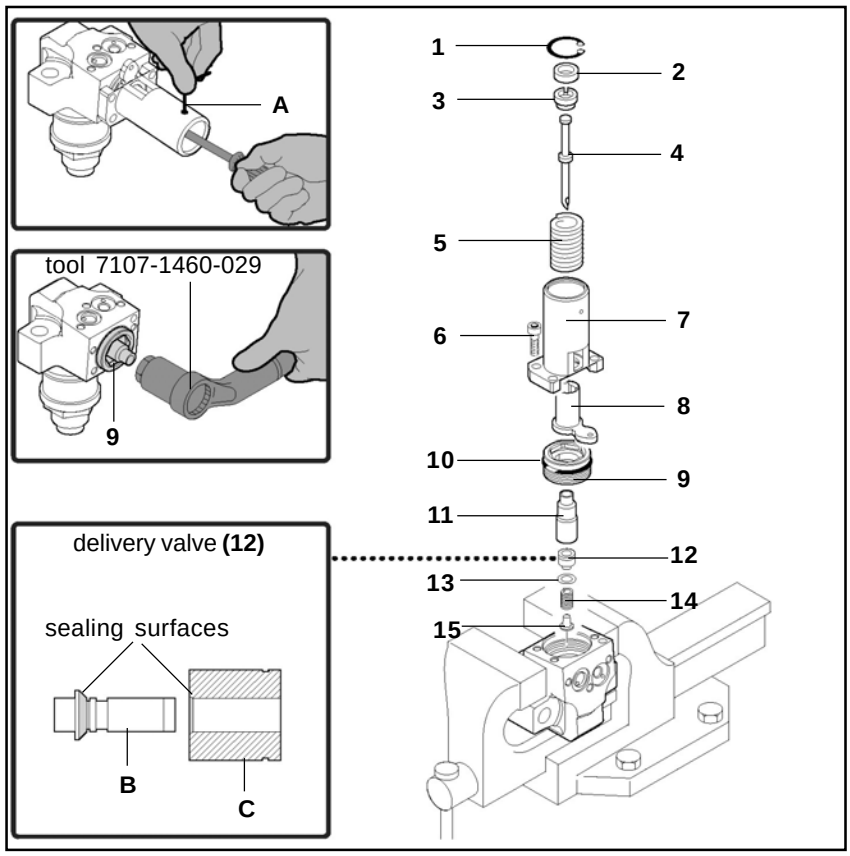
The needle (B) and the valve seat (C) must be assembled as shown in the figure.

12 - Assemble the barrel **(11)** and tighten the ring nut **(9)** provided with a new O-ring **(10**).

Important

Rotate in an alternating way the ring nut during assembling to avoid damaging the O-ring (10).

13 - Assemble in sequence all parts **(5-4-3-2**) on the support **(7)**.
14 - Press down part **(2)** to fit the pin **(A**).
15 - Reassemble the stop ring **(1**).



16 - Rotate the plunger **(4)** by means of the control blade **(29)** as shown in the figure.

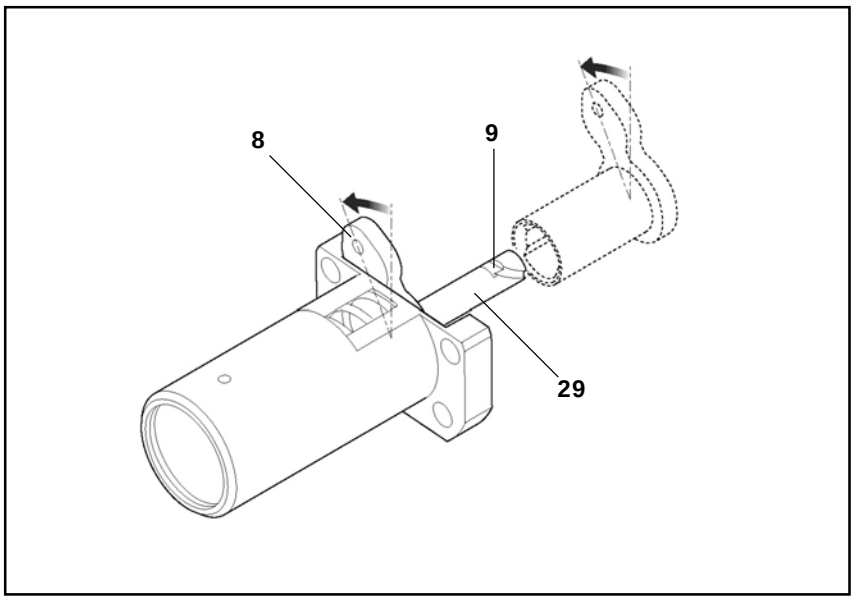
17 - Insert the lever **(8)** and engage it in the plunger **(4**).

Caution - Warning

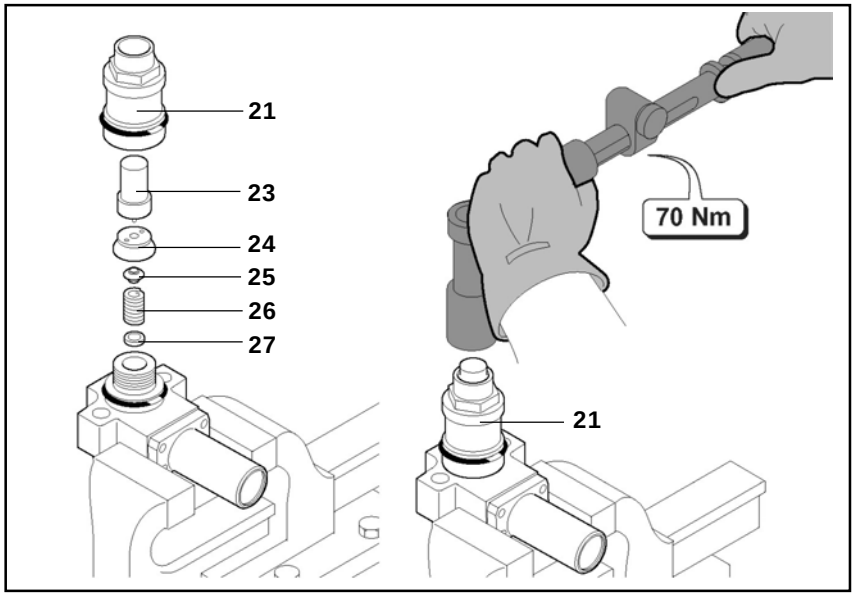
Check that the position of both lever (8) and plunger control blade (29) is the same as that shown in the figure.
If the control blade is positioned in a different way, the engine may not run.

18 - Tighten the screws **(6)** to join the support to the injector pump case .

19 - Press down hard on the pump collar to remove the pin **(A**).



8.14.2 Replacing nozzle-injector



Important

Replacement may be carried out with the engine installed on the machine.

1 - Disassemble the injection pump (see "Disassembling injection pumps").
2 - Loosen the ring-nut **(21)**.
3 - Extract the nozzle **(23)** and the parts **(24-25-26-27)**.
4 - Check that all components are intact and, if necessary, replace them with original spare parts.
5 - Reassemble the parts **(27-26-25-24)**.
6 - Assemble a new nozzle **(23)**.
7 - Tighten the ring nut **(21)** to a final torque of 70 Nm.

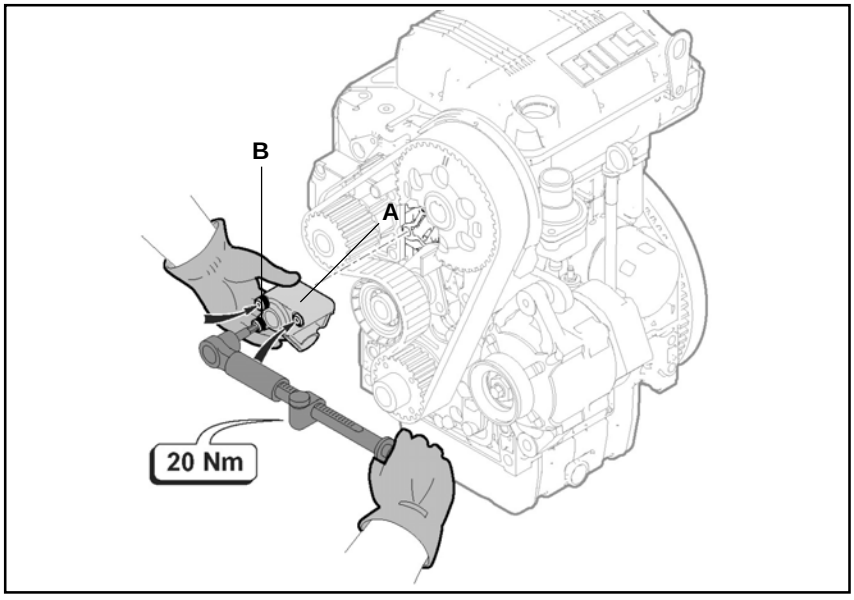
Important

Check the setting (see "Injector pump setting") since it could be necessary to replace the adjusting shim (27) and the spring (26).

8 - Repeat the same operation on the other injector.

9 - Assemble the injector pump (see "Injector pump assembly").

8.15 REPLACING THE COOLING FAN SUPPORT



Important

Replacement may be carried out with the engine installed on the machine.

1 - Switch off the engine and leave to cool.

2 - Disassemble the cooling fan belt drive (see "Removing the cooling fan belt drive").

3 - Remove the belt drive cover (see "Disassembling timing belt casing").

4 - Remove the support **(A)**.

5 - Install the new support.

6 - Tighten the screws **(B)** to a torque of 20 Nm.

7 - Mount the belt drive cover (see "Assembling the belt drive cover").

8 - Replace the cooling fan belt drive (see "Installation of the cooling fan belt drive")

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